DOCUMENT RESUME

ED 216 681 IR 010 155

TITLE	Evaluation of Cassette Braille.
INSTITUTION	VSE Corp., Alexandria, VA.
SPONS AGENCY	Library of Congress, Washington, D.C. National Library Service for the Blind and Physically Handicapped.
REPORT NO	LC-16-RD-81
PUB DATE	31 Dec 81
CONTRACT	LC-2038
NOTE	117p.; Figures may not reproduce on microfiche.
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	*Blindness; *Braille; Comparative Analysis; Costs; *Electronic Equipment; Library Services; *Magnetic Tape Cassettes; *Participant Satisfaction; Reading Material Selection; Reading Rate; *Visual Impairments

ABSTRACT

A study conducted to determine user acceptability of cassette braille systems addressed three concerns: (1) user reaction to the basic concept of cassette braille, (2) the determination of the strong and weak features of the cassette braille machines currently available, and (3) the determination of those features of braille machines which would be desirable in future production. Blind readers from five cities participated in this study, which was initiated in September 1979 and completed in December 1981. They received machines and operating instructions and were asked to keep logs recording their experience with the cassette braille system. They were also interviewed and tested, and asked to complete a questionnaire. The study indicated that the concept of paperless braille appears to have been well received. However, the equipment currently available, as used in this study, needs considerable engineering development before it could be placed into acceptable use. (Author/LLS)

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Report No. 16-RD-81

ED216681

EVALUATION OF CASSETTE BRAILLE

Prepared for

LIBRARY OF CONGRESS

NATIONAL LIBRARY SERVICE FOR THE BLIND

AND PHYSICALLY HANDICAPPED

1291 TAYLOR STREET
WASHINGTON, D.C. 20542

December 31, 1981

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EXECUTIVE SUMMARY

The National Library Service (NLS) currently provides paper braille materials free of charge to those patrons requesting them. Advances in electronic technology have fostered the development of cassette braille systems. NLS funded a study to determine user acceptability of this "paperless" braille system. Cassette braille will be considered only if its use does not compromise the quality of service to the blind and is a cost effective method of providing braille.

Three concerns were addressed in the study. First and most fundamental was user reaction to the basic concept of cassette braille. The second concern was to determine the strong and weak features of the cassette braille machines currently available. The third concern was to determine those features of braille machines which would be desirable in future production.

NLS provided the machines used in the study. They were the Elinfa Digicassette and the TSI VersaBraille. The Braillocord machine was originally intended for evaluation but was later dropped from the program because a system to produce cassette tapes for the Braillocord was not available within the time frame of this study. This study was initiated in September 1979 and was completed in December 1981. Blind readers from five cities participated. They received machines and operating instructions and were asked to keep logs recording their experience with the cassette braille system. They were also interviewed and tested by VSE personnel and were asked to complete a questionnaire developed by VSE and approved by NLS. The data appearing in this report was generated from these responses.

The concept of paperless braille appears to have been well received. However, the equipment currently available, as used in this study, needs considerable engineering development before it could be placed into acceptable use. At this time, therefore, it is difficult to provide an accurate estimate of future costs. However, there appears to be potential for cost savings.

The study revealed that the majority of the participants were willing to accept cassette braille. Seventy-two percent of the participants indicated that they would have no significant problems in converting to cassette braille. It is believed that many of the problems expressed by the remaining 28 percent could be eliminated by better machine design.

The improvements required are:

- Reduction in weight
- A more easily manageable index system
- Increased word display to improve reading continuity
- Enhanced carrying capability
- Ease of operation
- Improved reliability

The major reliability problem in both the Elinfa and VersaBraille relates to the piezoelectric reed used to actuate the braille pins. It is felt that considerable development is required in this area.

Users reported excessive fatigue in use of the existing machines, particularly with the VersaBraille, which has a poor configuration of display and control keys for long term reading. Improvement in this area will have considerable impact on user acceptability.

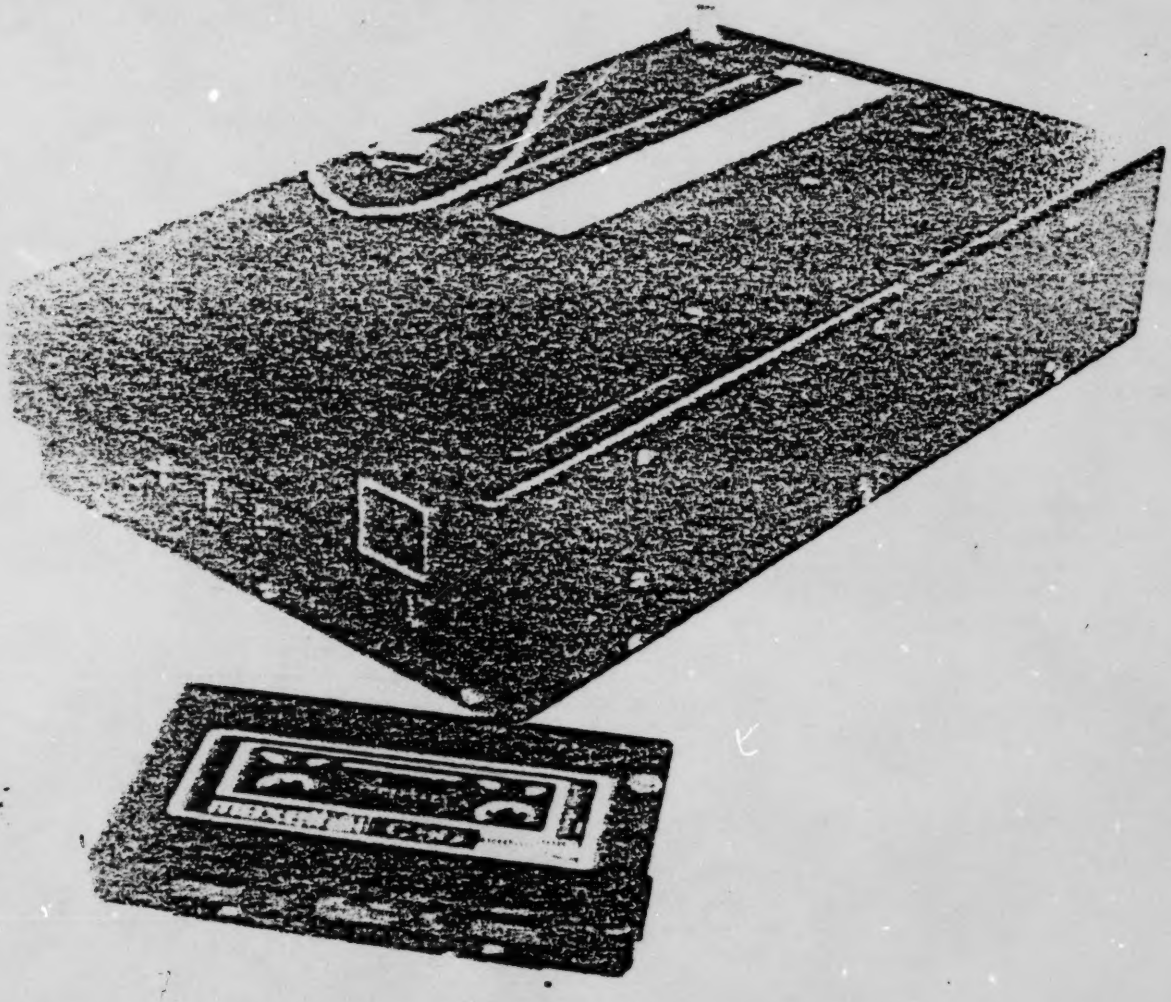


Figure 1-1. Elinfa Machine

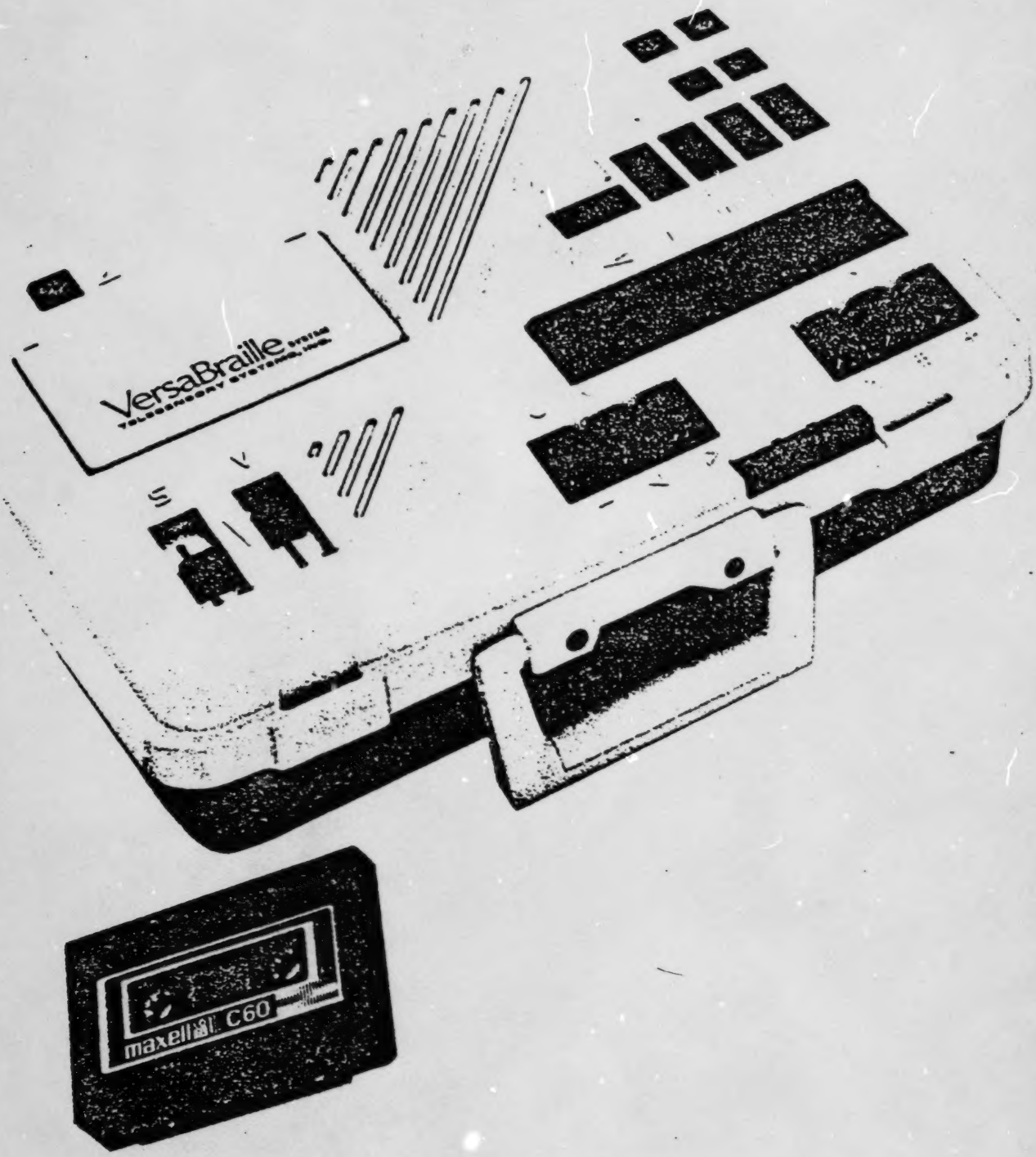


Figure 1-2. VersaBraille Machine

PART I.

CONCLUSIONS AND RECOMMENDATIONS

Section I. ACCEPTABILITY OF CONCEPT OF CASSETTE BRAILLE

1-1 CONCLUSIONS. Results of the study indicate that at this time a majority of the participants prefer paper braille. However, assuming that the "no preference" participants would accept either concept, it can also be stated that a majority of the participants would accept cassette braille. This would certainly be true if the machine improvements discussed later in this report can be effected.

Table 1-1. Summary of Participants' Reactions to Concept (Percent)

CATEGORY	PERCENT		
	Prefer Cassette Braille	Prefer Paper Braille	No Preference
1. Ability to initially locate specific articles.	21	67	12
2. Ability to skim material - both forward and backward.	25	63	12
3. Space requirements for braille material.	99	1	0
4. For reading speed.	27	55	18
5. For reading comprehension.	13	32	55
6. Missing or unreadable characters or words.	28	30	42
7. If you are reading for short periods of time (30 minutes or less).	37	30	33
8. If you are reading for long periods of time (30 minutes or more).	31	50	19
9. Produces less fatigue.	22	56	22
10. Ability to maintain your place while reading.	57	21	22

Section II. STRONG AND WEAK MACHINE FEATURES

1-2 CONCLUSIONS. Reliability of both the Elinfa and VersaBraille machines, which was an expressed concern of many participants, is extremely poor. Also, certain features, particularly those concerned with article location and indexing, are unacceptable. Tables 1-2 and 1-3 are summaries of the participants' reactions.

Table 1-2. Summary of Participants' Reactions to Elinfa Machine Features (Percent)

	PERCENT RATING				
	1*	2	3	4	5
1. Dot height of the display.	-	4	39	24	33
2. Dot spacing of the display.	-	-	35	22	43
3. Firmness of dots in the display.	-	12	24	35	29
4. The placement of the display on the machine.	-	-	41	21	38
5. The length of the braille display.	14	47	17	12	10
6. The placement of the controls on the machine.	6	25	51	14	4
7. The ease with which you are able to operate the controls.	2	25	31	28	14
8. The method for bringing up the next line.	18	20	23	31	8
9. The method for going back one line.	46	29	19	4	2
10. The method to locate a specific article.	33	23	29	10	4
11. The time required to locate specific articles.	25	29	29	13	4
12. The portability of the machine.	-	4	19	23	54
13. The machine when used in the battery mode.	-	5	14	33	48
14. The machine when used with the power cord.	-	2	7	27	64

* 1 Unsatisfactory
2 Below average
3 Average
4 Above Average
5 Excellent

Table 1-3. Summary of Participants' Reactions to VersaBraille Machine Features (Percent)

	PERCENT RATING				
	1*	2	3	4	5
1. Dot height of the display.	-	5	27	5	63
2. Dot spacing of the display.	-	-	21	16	63
3. Firmness of dots in the display.	-	11	5	21	63
4. The placement of the display on the machine.	5	11	42	21	21
5. The length of the braille display.	5	37	31	16	11
6. The placement of the controls on the machine.	-	16	47	21	16
7. The ease with which you are able to operate the controls.	-	5	41	27	27
8. The method for bringing up the next line.	-	16	52	16	16
9. The method for going back one line.	5	5	36	27	27
10. The method to locate a specific article.	-	5	32	21	42
11. The time required to locate specific articles.	-	26	42	11	21
12. The portability of the machine.	5	26	32	26	11
13. The machine when used in the battery mode.	5	16	42	11	26
14. The machine when used with the power cord.	5	16	32	31	16

* 1 Unsatisfactory
2 Below average
3 Average
4 Above Average
5 Excellent

1-3 RECOMMENDATIONS. An acceptable reading machine should have qualities as outlined below.

a. Machine Design

(1) Indexing. The reading machine should have the capability to automatically locate specific articles. The participants want the index on the tape. They also want the ability to select specific articles without manually searching the entire tape.

It is proposed that the tape carry only the index that appears in the reading material. The TSI system has two indexes, one full and one abbreviated, both of which have to be used to access the text material. Also the index should reference location numbers instead of page numbers and these numbers should be continuous throughout the entire text. The reader could then input the location number and the machine would automatically find the article.

(2) Line length. It is believed that the addition of two more cells to the 20 cell line could add an extra word per line. A more detailed study should be made to determine the average length of a Grade 2 braille word. The line length of the machine should be made to make maximum use of the average word length.

Magazine	Average cells used per line display	Average Remaining
Psychology Today	17	4
Playboy	19	3
Better Homes and Gardens	17	3
Family Health	17	3
Braille Variety News	17	3

(3) Portability. The Elinfa machine used in the program weighs approximately five pounds and the VersaBraille weighs approximately ten pounds. There were a number of complaints that the VersaBraille was too heavy, but very few complaints about the Elinfa. Therefore, it is suggested that the weight be kept under ten pounds and as close to five pounds as possible. An acceptable reading machine should have a soft carrying case with a cover flap that allows the machine to be used while in the case.

(4) Controls. Controls for the machine should be grouped together and each control should have a tactile symbol. The machine should have a positive acting advance bar. The advance bar should be such that it can be operated with either the right or left hand and not interfere with the reading of the display. The machine also has to have the capability to back up one line at a time. The controls

should be such that they can be locked into place, if desired. This is applicable to the fast-forward and rewind. (The drive mechanism should have a high speed mode so that the fast-forward and rewind can be done in minimal time.) All controls should be conveniently located for lap use.

(5) Battery Mode. If the machine is to have a battery operational mode, the charger should be built into the machine. The minimum time for battery operation should be four hours, although eight hours is desirable.

(6) Volume Control. If the machine has an audio warning system for beginning or ending of a function, the audio should have a volume control.

(7) On/Off Switch. When the machine is turned off, the tape should remain in the machine and not automatically be rewound or advanced. The participants want to be able to turn off the machine and be able to come back and start reading where they left off, without having to relocate the material. It is suggested that the power automatically be cut off if the machine sits idle for more than five minutes.

(8) Reliability. Reliability of the pin drive mechanism will have to be improved. During the program, both the Elinfa and VersaBraille had to be returned for pin height adjustment. There are two possible causes for this problem: Normal handling and/or strain on the drive mechanism. The problem of straining the drive mechanism could be corrected by locking the raised pins in place and letting the drive mechanism relax after the pins have been moved to the proper height.

(9) Head. Misalignment has been a cause for tapes being unreadable. Special consideration should be given to holding the head alignment during use.

(10) Tape Format. Cassette braille machines used by NLS should have only one format of digital input-output. It is important that the system have a high input density, or Baud rate, so that a large amount of text material can be put on a tape.

b. Master Tape Recording. During the program, this process was advanced from text material being entered into the computer by an operator at a CRT terminal, to automatic scanning for computer entry. An even more advanced method would be to use composition or galley tapes to enter material into the computer.

c. Selection of Material. Participants expressed a specific desire to have news type items in braille. The paperless format would allow for the timely delivery which is essential for this type of information. The ability to electronically transfer material for cassette use should hasten the duplication process. Also, the tremendous reduction in bulk will facilitate mailing.

PART II

SUMMARY OF PROGRAM

Section I. OBJECTIVES

2-1 PURPOSE. NLS maintains a variety of braille books and magazines which are supplied free to handicapped readers. With the advent of cassette braille machines, NLS determined that a study should be conducted to determine if cassette braille is a viable reading medium.

2-2 SCOPE. VSE Corporation was awarded a contract to conduct a study in close coordination with NLS. It was agreed that NLS would direct the program and supply cassette braille machines; VSE would conduct the study.

2-3 INTENT. The results of the study would provide meaningful data in the areas of acceptability of the concept of cassette braille, strong and weak features of machine and the feasibility of obtaining low-cost machines. NLS could then use the data for planning purposes.

Section II. RESULTS OF STUDY

2-4 ACCEPTABILITY OF CONCEPT OF CASSETTE BRAILLE. Table 4-13 (page 4-18) presents a summary of participants' reactions to the concept. The results of the questionnaire, participants' comments and an interpretation of them indicate that answers were influenced by the machine which was used. The "no preference" choice was difficult to interpret but probably means that, for a given category, the machine and paper braille are equally acceptable. The data indicated that for Items 1, 2 and 4, the majority prefer paper. There was almost total preference for the machines for Item 3. The other six items are not as clearly defined. Explanations of specific items are:

(1) Elinfa/Concept.

Item 1. Ability to initially locate specific articles. The majority preferred paper. The Elinfa uses a paper index which most people found to be very inconvenient because the index had to be kept with the machine to be useful. The cumbersome and inexact method of locating the beginning of an article was a major problem. The drive is very slow and can take a relatively long time to find the article.

Item 2. Ability to skim material. Most readers preferred paper because of the difficulty in going backward or forward to a specific point on the tape.

Item 3. Space requirements. Everyone agreed that cassette braille is far superior to paper braille.

Item 4. Reading speed. The majority preferred paper. The faster readers found that the short line and the time span required to store the 120 character block in the memory slowed them down. The slower readers who had trouble keeping their place with paper read faster with the machine and were not bothered by the time delay.

Item 5. Reading comprehension. There was no clear preference. The short line caused some people to have a problem with continuity. The major problem was not being able to go back one line easily in most cases.

Item 6. Missing or unreadable characters. No clear preference. The Elinfa users received the first digital tapes which had errors caused by problems with the master tape. These problems were lessened with time, but were never completely solved. Participants did not feel that this was a significant problem. Forty percent had no preference.

Item 7. When reading for short periods (30 minutes or less). The majority preferred cassette over paper.

Item 8. When reading for long periods (30 minutes or more). The majority preferred paper over cassettes. One factor is that many people enjoy reading in bed and found that the machine was not as suitable as paper.

Item 9. Produces less fatigue. Over half felt that paper produces less fatigue because of the ability to shift reading positions.

Item 10. Ability to maintain your place while reading. The majority preferred the machine.

For items 1, 2 and 4, the majority preferred paper and for item 3, they all preferred the machine. The other six items are not as clearly defined.

(2) VersaBraille/Concept.

Item 1. Ability to initially locate specific articles. The VersaBraille has the index on the tape and will go directly to a specific article.

Item 2. Ability to skim material forward and backward. The VersaBraille can go forward or backward one line at a time, one paragraph at a time, or one page at a time, as long as the reader stays within the same article.

Item 3. Space requirements for braille material. There was 98 percent agreement that the cassette braille is superior to paper braille.

Item 4. Reading speed. About half felt paper was faster. The time required for the machine to change to a new page was too long.

Item 5. Reading comprehension. The majority had no preference. They could not notice any difference between the two concepts.

Item 6. Missing or unreadable characters or words. The majority had no preference.

Item 7. When reading for short periods (30 minutes or less). The majority had no preference. One drawback was that when the machine is turned off the reader loses his place.

Item 8. When reading for long periods (30 minutes or longer). The machine is fatiguing when used for long periods of time.

Item 9. Produces less fatigue. Participants found that their hands, arms, and shoulders get tired when using the machine. The VersaBraille cannot conveniently be used away from a table.

Item 10. Ability to maintain place while reading. The majority preferred the machine.

2-5 STRONG AND WEAK MACHINE FEATURES. Presented below is a summary of questionnaire ratings, reading speeds and comprehension, participants' comments and conclusions.

a. Questionnaire Ratings. Tables 2-1 and 2-2 are summaries of the participants' reactions to machine features.

Table 2-1. Summary of Participants' Reactions to Elinfa Machine Features (Quantity)

FEATURE	QUANTITY RATING*				
	1	2	3	4	5
1. Dot height of the display.	-	5	23	12	20
2. Dot spacing of the display.	-	2	20	11	29
3. Firmness of dots in the display.	-	6	14	18	24
4. The placement of the display on the machine.	-	1	22	11	24
5. The length of the braille display.	8	25	12	7	8
6. The placement of the controls on the machine.	4	14	28	10	4
7. The ease with which you are able to operate the controls.	2	13	16	19	11
8. The method for bringing up the next line.	10	13	12	17	8
9. The method for going back one line.	26	17	12	2	1
10. The method to locate a specific article.	20	16	15	6	2
11. The time required to locate specific articles.	18	17	16	6	2
12. The portability of the machine.	-	5	10	12	32
13. The machine when used in the battery mode.	-	2	8	16	26
14. The machine when used with the power cord.	-	2	4	14	35

* 1. Unsatisfactory
2 Below average
3 Average
4 Above Average
5 Excellent

Table 2-2. Summary of Participants' Reactions to VersaBraille Machine Features (Quantity)

FEATURE	QUANTITY RATING*				
	1	2	3	4	5
1. Dot height of the display.	-	3	9	8	31
2. Dot spacing of the display.	-	-	9	11	31
3. Firmness of dots in the display.	-	4	5	10	32
4. The placement of the display on the machine.	2	6	16	14	13
5. The length of the braille display.	3	11	16	15	6
6. The placement of the controls on the machine.	-	7	17	13	14
7. The ease with which you are able to operate the controls.	-	1	12	19	19
8. The method for bringing up the next line.	-	6	16	12	17
9. The method for going back one line.	1	3	15	15	17
10. The method to locate a specific article.	2	2	15	14	18
11. The time required to locate specific articles.	1	11	15	14	10
12. The portability of the machine.	4	10	16	11	10
13. The machine when used in the battery mode.	1	8	16	9	14
14. The machine when used with the power cord.	1	4	13	20	13

* 1. Unsatisfactory
2 Below average
3 Average
4 Above Average
5 Excellent

b. Participants' Comments. Over the entire period of participant performance, many spontaneous comments and recommendations about machine features were recorded by the interviewers. A summary follows.

(1) Elinfa Machine Features.

- Move the counter key next to the fast forward button.
- Increase the speed of the transport.
- Decrease time between blocks of 120 cells.
- Fast forward key should lock into place.
- Cassette door and eject lever should be easier to work.
- Move the touch switch to be in line with, and at either end of the display.
- Dot height varies - uneven display.
- Should have a volume control.
- There should be a method to backspace one line at a time.
- The display should be longer.
- Fingers stick to display in hot weather.
- The machine needs a soft carrying case.
- Have the index on the tape.
- Put a handle and cover on the machine.
- Have a tactile rather than audible cue for the block changes so deaf/blind persons can use the machine.
- It is difficult to locate a specific article using the index.

(2) VersaBraille Machine Features.

- Time to change from page to page is too long.
- End of article should be indicated.
- Cover is hard to remove from machine.
- Cover is hard to replace on machine.
- Machine should be lighter in weight.

- Eject button is too accessible. Accidental touching causes tape to rewind and eject.
- Low battery indicator does not have enough sensitivity.
- Charger is too large and too heavy.
- Cord from outlet to charger should be longer and cord from charger to machine shorter.
- Allow machine to be charged with cover in place.
- Put tactile symbols on keys.
- Place advance bar on both ends of display.
- Place backup key near advance bar.
- Separate page key from chapter and paragraph keys.
- Pins not in use can be detected.
- Search function should be more selective.
- Would like to turn machine off and be able to return to same position of tape by simply turning machine on.
- Provide an automatic power cut-off switch for unattended machine.
- Charger should be part of machine.
- Eliminate word key.
- Place display in front of braille keyboard and leave room to rest hand on.

c. Elinfa and VersaBraille Machine Features Comparison. As part of the Washington, D.C. phase of the evaluation, five of the readers from Baltimore, Maryland who had evaluated an Elinfa machine were selected to evaluate a VersaBraille. They were chosen on the basis of being good participants and represented a wide range of reading speeds. Also, these readers had expressed varied opinions of the Elinfa machine. Three read at a higher percentage of their paper reading speeds on the VersaBraille, while two read at a lower percentage. No clear advantage for either machine could be determined. Two readers complained of soreness in their wrists and shoulders while reading the VersaBraille, a complaint not voiced about the Elinfa. Two readers felt that the Elinfa was much more comfortable to hold on their lap, a particular advantage when reading away from home. All five readers liked the relative ease of finding the beginning of an article on the VersaBraille, as compared to the Elinfa. However, the index-related disadvantage of having to go to the beginning of the tape each time the VersaBraille was turned on was also voiced. All five readers preferred the VersaBraille 1000 character memory to the Elinfa's 120 cell memory, commenting that it made reading more continuous.

d. Conclusions. Conclusions and explanations of specific items are:

(1) Elinfa/Features. The following comments pertain to the four items that 50 percent or more of the participants found to be below average or unsatisfactory.

Item 5. Length of braille display. Participants had a difficult time switching between the standard braille line (40 characters) and the 20 character lines. People did not use the machine exclusively and some people found the interruption by the short line made comprehending the meaning more difficult. Not being able to reread a line with ease also caused problems.

Item 9. Method for going back one line. To return to a line previously read on the Elinfa machine, the reader had to be reading the second line of the six block of memory. It took several steps to retrieve any other line.

Item 10. Method to locate a specific article. Over half found this procedure too cumbersome.

Item 11. Time to locate a specific article. The transport is slow, adding to the difficulty in finding a specific article.

The following items were rated below average or unsatisfactory by 25 percent or more:

Item 6. Placement of controls on the machine. Some readers felt that the counter and multi-function keys were not in a good location. Also, there were complaints about the position of the touch switch.

Item 7. Ease of operating the controls. Common complaints involved the force required to operate the tape transport keys. Readers felt the fast forward key should lock.

Item 8. Method for bringing up the next line. Opinions varied from very positive to very negative on the touch switch. A specific problem was brushing over the switch inadvertently which causes the line to advance before the reader is ready.

The rest of the items, which are listed below, were rated average or above by a majority of the readers.

Dot height of display

Dot spacing of display

Firmness of dots in display

Placement of display on machine

Portability of machine

Machine used in battery mode

Machine used with power cord

(2) VersaBraille/Features. There were three areas in which 25 percent or more of the participants felt that the machine was below average or unsatisfactory. They are:

Item 5. Length of braille line. The 20 cell line was not long enough for easy reading.

Item 11. Time required to locate specific articles. Participants did not like the idea of having to go to the index before going to an article. They also felt that the procedure to find an article was too long.

Item 12. Machine portability. The machine is too heavy.

The following features were rated average or above average by a majority of the readers:

Dot height of display

Dot spacing of display

Firmness of dots in display

Placement of display on machine

Placement of controls on machine

Ease of operating controls

Method for bringing up the next line

Method for going back one line

Method to locate a specific article

Machine used in battery mode

Machine used with power cord

e. Reading Speed and Comprehension.

(1) Test Results. Table 2-3 below is a summary of participants' reading speeds for paper braille and cassette braille.

Table 2-3. Summary of Participants' Reading Speeds for Paper Braille and Cassette Braille

City	Words Per Minute	
	Paper Braille	Cassette Braille
Baltimore - Elinfa	91	73
Little Rock - Elinfa	84	58
Oklahoma City - Elinfa	85	63
Los Angeles - VersaBraille	116	104
Los Angeles*- VersaBraille	116	92
Washington - VersaBraille	104	83
Washington - Elinfa	83	64
All Cities	89	67

* Excludes Reader #11 who read at 315 wpm on machine

(2) Conclusions. The faster reader's speed and comprehension tend to be poorer when using the machine because he must read short lines and wait for pauses between 120 character blocks. The slower reader's speed and comprehension is improved, in some cases, when using the machine, apparently because short lines and pauses are not a significant factor at slow reading speeds. Specific results for each machine are:

a. Elinfa. Tables 4-1 through 4-4 (pgs 4-5 through 4-8) contain the reading speed test data for the Elinfa participants. The tables do not reflect the total number of participants in the program because some participants from each city were not available for the post-test and interview due to illness, lack of time, etcetera.

In each table participants are ranked by their reading speed on paper. Except for one case in each table, the upper half of the readers reads faster on paper than with the machine. One exception is that one participant had an equal reading speed on both. Reading speeds from the post-test show that the faster reader is slowed down when he uses the machine. Of the slower readers there were six who read faster or at an equal rate when using the machine.

The reading speeds for all Elinfa participants were combined to determine an average reading speed for paper and cassette braille. The average was 86 WPM for paper and 65 WPM for cassette braille. A further comparison of the reading speed data was made by dividing the group into those who read 87 WPM or above and those who read 86 WPM or less.

	87 WPM or above	86 WPM or less
No. of Participants	28	32
Paper average	121	55
Cassette average	85	47

This data indicates that the faster reader is slowed down when he reads with the machine. Two possible reasons for the slower reading is the short line (20 characters) and the pause when the 120 character block is stored in the memory.

The comprehension test was given to see if the article that was read was understood. The proficiency rating, which equates reading speed and comprehension, shows that there is a vast spread between the reading capabilities of the participants in all four cities where the Elinfa was tested. The one significant point from this data is that some of the slower readers are more proficient when using the cassette braille.

b. VersaBraille. The average reading speed was 108 WPM for paper and 91 WPM for machine, but this data is offset by one person whose reading speed was 102 WPM for paper and 315 for machine. When this reader is excluded from the machine reading speed results, the average reading speed for machine is then 87 WPM. The difference between the average paper reading speed and average machine reading speed of this group is 21 WPM, which is about the same difference (24 WPM) that was found with the Elinfa.

Section III. Low Cost Machine Recommendations

2-6. COST. Since the desired machine design has not been established, only rough estimates which were obtained from the manufacturers are presented in Table 2-4 below.

Table 2-4. Comparison of Machine Costs

Category	Elinfa	VersaBraille
Cost of each machine used in the study (approximate)	$1,600 (read only)	$4,350 (read/write)
Current model list price (each)	$4,850 (DC-20M)	$6,000 (P-2)
Estimated price each at a quantity buy of 1000	$2,000	Not Available

PART III

DISCUSSION OF PROGRAM EVENTS

Section I. MACHINES

3-1 SELECTION. NLS selected three machines for the study. These were the only ones in production (worldwide) at that time. The Braillocord, manufactured by AID Electronics, Germany, was not available for the study due to cassette production problems. The Elinfa, manufactured by Elinfa, France and the VersaBraille, manufactured by Telesensory Systems, Incorporated, Palo Alto, California were used.

NLS desired machines that would read only - not record. The Elinfa machines purchased were Digicassette models with the record functions removed. The VersaBraille manufacturer was not able to remove the record function within the time frame necessary, so read/record machines were purchased, but only the read functions were evaluated.

NOTES

In June 1980, Triformation Systems, Incorporated purchased the patent and manufacturing rights for the Digicassette and took over the braille cassette program. The Elinfa machine used in this study has no resemblance to the Elinfa DC-20-M Digicassette, which is presently being marketed by Triformation Systems. The DC-20-M Digicassette is a word processor using a microprocessor with a braille display which can be used to store or recall information.

The P1A VersaBraille machine used in this study was the same machine being marketed by TSI at that time. This model has been revised and is now being sold as a P1B or P2B.

3-2 DESCRIPTION AND OPERATION. Description and operation of the Elinfa and the VersaBraille is explained in the following paragraphs.

a. Theory of Operation. The cassette braille machine used in this study is a magnetic tape reader. The output is converted into a series of pins which display braille characters. The reading material is stored in digital format on magnetic tape. In the reading mode, the tape output is processed by the machine electronics which control the braille display. The display consists of a 20-cell line with each cell representing one braille character with appropriate notations, punctuation, or blanks. Succeeding lines of information are produced as desired. The machine displays only complete words, which can result in empty spaces at the end of the display. Both the Elinfa and the VersaBraille machines have this basic presentation of the reading material, but the operation of the machines varies.

b. Elinfa Description. The Elinfa (Figures 3-1 and 3-3) is 10-1/2 inches wide, 6 inches deep, 2 inches high, and weighs approximately five pounds. It operates from an internal battery or from a 120 VAC outlet through an AC converter. The Elinfa was furnished with a hard plastic case lined with a foam material. Table 3-1 indicates control functions.

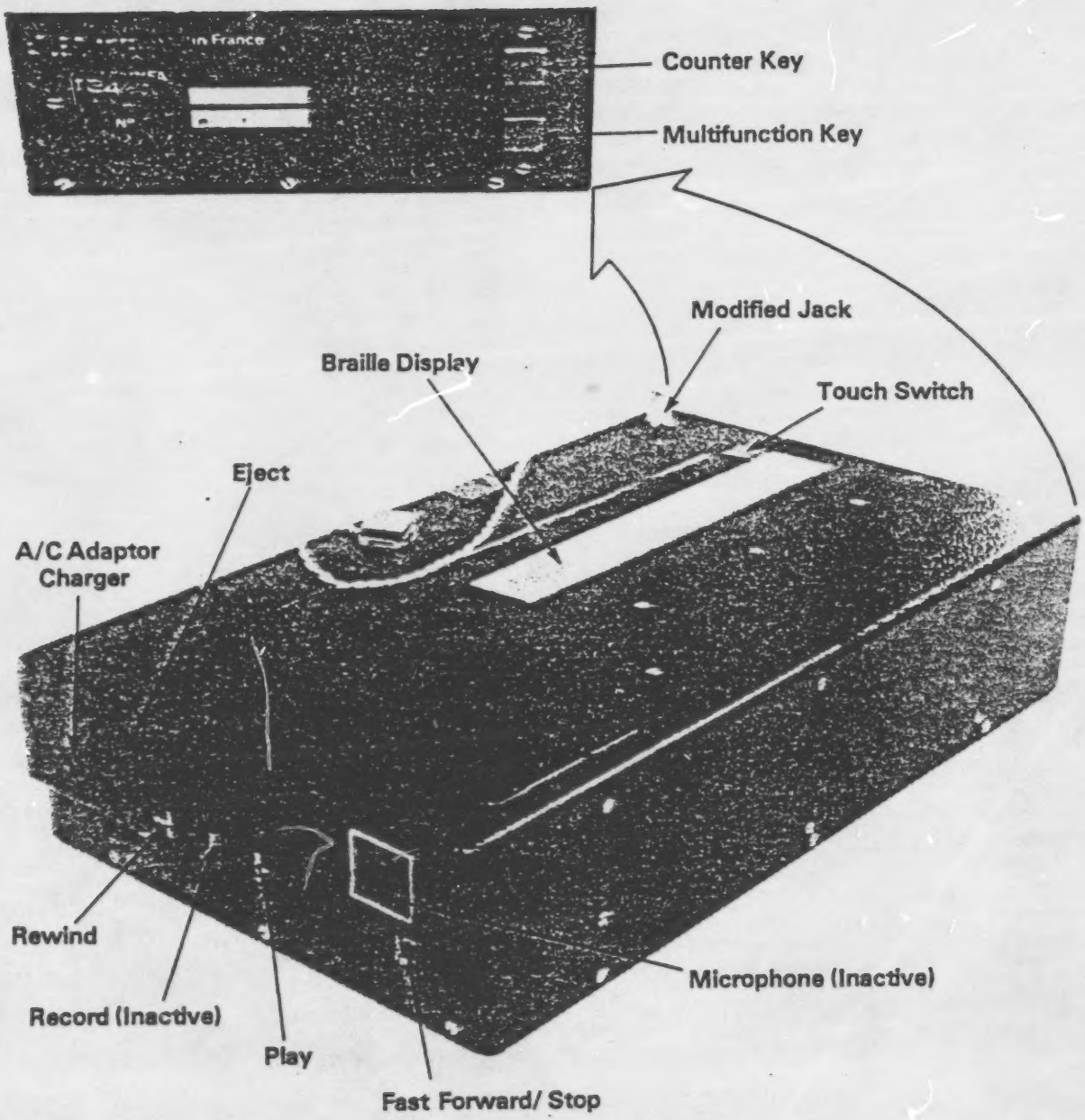


Figure 3-1. Elinfa Controls

Table 3-1. Elinfa Control Functions

Control	Function
Play Key	Push/Lock. Activates electronics which puts machine in state of readiness for reading.
Touch Switch	Two contact bars. Touching these bars brings up a new line on the display. (Prior to distribution in Washington, D.C., an optional momentary contact switch was installed.)
Rewind Key	With machine in the play mode, cassette will rewind while key is held in. With machine not in play mode, key may be held in or locked into place (pushing the Stop Key unlocks the Rewind Key).
Fast Forward/Stop Key	Two functions: Push and release to turn machine off. Hold key in, press Multifunction Key, then touch the Touch Switch and machine will fast forward (key must be held in to keep machine fast forwarding).
Multifunction Key	Hold key in then touch the Touch Switch and the display will go back to the first series of characters in the memory. (Pressing the Multifunction key will also silence the error tone.)
Index Key	Press for a number to appear on the display which represents the location of material on the tape.
Ejection Button	Push down (with considerable force) to eject cassette.
Adapter Plug	Used to plug machine into an AC outlet.

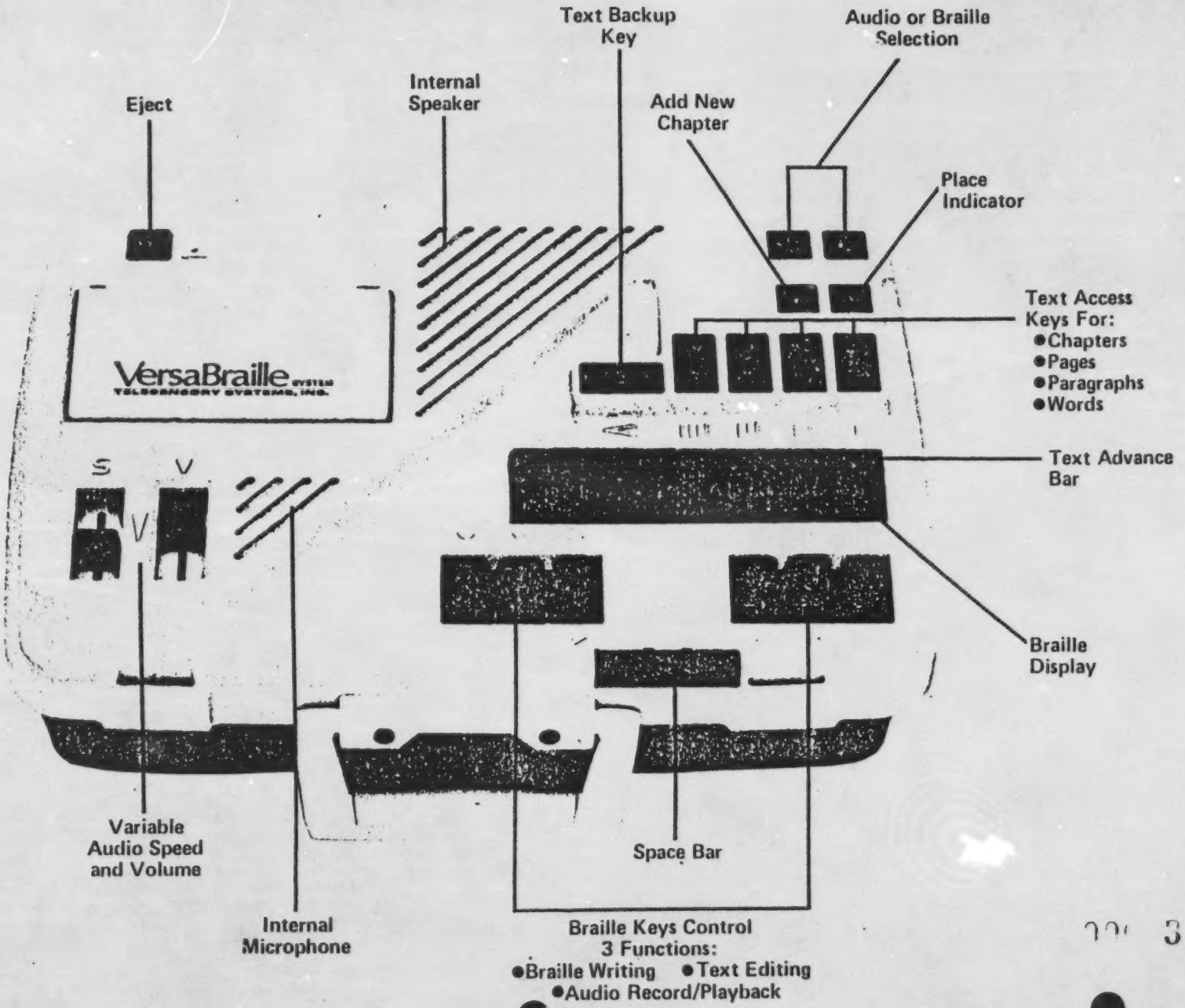
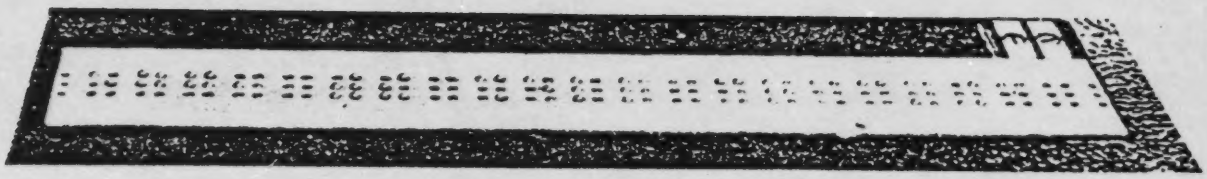


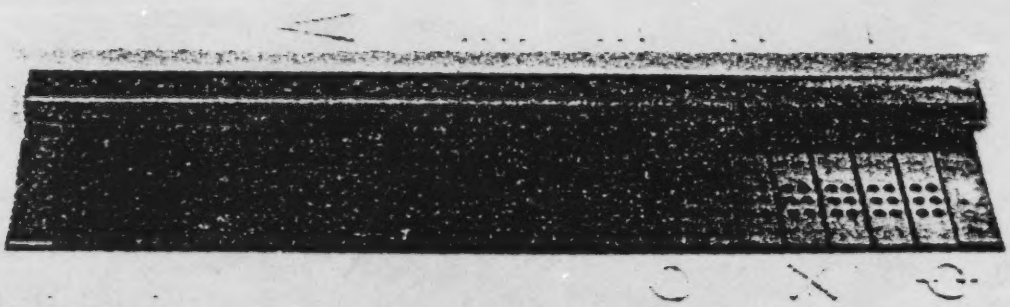
Figure 3-2. VersaBraille Controls

Table 3-2. VersaBraille Control Functions

Control	Function
On/Off Switch	Rocker type. Automatically opens cassette door when machine is turned on.
Braille Select Key	Push to put machine in braille mode of operation.
Advance Bar	Push to bring up new line on display.
Back-Up Key	Push to bring back previous line on display
Volume Control	Slide type. Adjusts volume of user prompting tones.
Eject Key	Push to stop all machine functions and open cassette door.
Text Access Keys	Four keys: Chapter, Page, Paragraph, and Word. Used in conjunction with Advance Bar or Backup Key to advance or backup one chapter, page or paragraph. The Word Key is used to input a specific word, a string of letters, or a combination of letters or words into the memory.
Place Indicator Key	Push to display title of article being read, current page number, and character number of first character which had been on display. (Press Advance Bar to bring back regular text material.)
Braille Keys and Space Bar	Used to input material into the microprocessor. (Identical to key patterns in common use, such as those on a Perkins Brailler.)



A — ELINFA



B — VERSABRAILLE

Figure 3-3. Elinfa and VersaBraille Braille Displays

c. Elinfa Operation. The Elinfa system stores digital input on audio cassette and can use any length of tape up to a C-90. The following procedure is used to read with the machine. The cassette is inserted into the machine and the machine turned on by pushing in the play button until it locks. The touch switch is then activated to advance the cassette tape to the first block of information. The material on the tape is stored in the memory in blocks of 120 characters. The display has a capacity for 20 cells; therefore, each 120-character block has six lines of braille. When the first block of material has been stored in memory, a beep is sounded. Touching the touch switch will then cause the first line of braille to be displayed. The reader brings up the next line by activating the touch switch. Immediately after the sixth line of braille has been displayed, a beep is sounded. The beep indicates the tape is being advanced and another 120 cells of material are being stored in memory. The tape transport only advances when a new block of information is required. When the material has been stored, a second beep is sounded, indicating that the machine is ready to advance to the next line.

Should the reader want to read a specific article, the paper braille index supplied with the cassette is used. At the end of the description of the article is an index number. The following procedure is used to find an article. The cassette has to be rewound to the beginning of the tape. The play key is then pressed in, and the multifunction key and index are then pressed simultaneously. This sets the counter number at zero which corresponds with the beginning of the tape. To locate the start of a specific article, the machine is put into the fast forward mode. The index key is pressed to display the index number of the tape at that instant, while the tape continues to advance. The index key must be pressed repeatedly and the display read quickly to prevent overshooting the desired number. The fast forward key should be released approximately five numbers short of the desired index number and the touch switch then used to advance the tape to the beginning of the article desired.

In order to reread a line, the reader has to go back to the beginning of the material in memory. This is done by pushing the multifunction key, followed by the touch switch. An exception is if the reader is on the first or the sixth line of a block. In these cases, the information is not in current memory. The only choice the reader has is to rewind the tape.

d. VersaBraille Description. The VersaBraille (Figures 3-2 and 3-3) is 14 inches long, 9-1/2 inches deep, 4-3/8 inches high, and weighs approximately 10 pounds. The VersaBraille is designed with a cover and handle and therefore does not need a carrying case. It will operate from an internal battery or a charger/AC adaptor. Table 3-2 contains an explanation of control functions.

e. VersaBraille Operation. Turning the machine on automatically opens the cassette door. When the cassette is placed in the machine and the door is closed, the display tells the reader to select the braille mode of operation. When the braille select key is activated, the microprocessor searches the tape to find the Table of Contents. The first title in the Table of Contents then appears on the display. The VersaBraille has two Tables of Contents, which were set up specifically for this study. One is an abbreviated version which describes the article in ten or fewer characters and the other gives the complete contents. To access the abbreviated contents, the reader uses the chapter key and the advance bar, in that order. Each successive article in the abbreviated contents is brought up in the same manner. To access the full contents, only the advance bar is used. If the reader is in the full contents mode, and finds an article he wishes to read, he must return to the abbreviated contents which describes the same article- the only way to get the text material. The reader has two options to return from the full contents to the abbreviated contents. By activating the chapter access key and the back-up key, the microprocessor will return the tape to the beginning of the contents. The reader then has to advance through the abbreviated contents until the specific article is found. The other option is to activate the chapter key and braille in the abbreviated title and then hit the advance bar. The microprocessor will find that specific article in the abbreviated contents. When the display shows the title of the abbreviated contents, the reader goes to the text material by pressing the advance bar. The material is brought up one line at a time by the advance bar. To go back one line the back-up key is pressed. The reader can move through the article by using the page or paragraph key and then the advance or back-up key. When the end of the article is reached, the reader can reread this article or go back to the abbreviated contents to select the next article.

The VersaBraille will search for any word on a page that is chosen. To find a specific word or letter string in the text, the word access key is pressed and the word is then written using the braille keyboard. The word must be checked for exact spelling as it appears in the text. The advance or back-up bar is then pressed and the machine searches the page for that word. If the machine is to be turned off before the reader has had a chance to finish the text, he can locate the page and character number by activating the place indicator button. When the reader wants to resume reading the article, he can go directly to where he left off.

3-3 DISTRIBUTION. Table 3-3 shows how the machines were distributed to the participants. Due to faulty machines and a lack of response from volunteers, machines were not distributed to participants as originally intended.

Table 3-3. Machine Distribution to Participants

City	Intended Quantity and Delivery Date		Actual Quantity and Delivery Date	
	Elinfa	VersaBraille	Elinfa	VersaBraille
Baltimore	25 (Oct 79)		20 (Jan-Feb 80)	
Little Rock	25 (Oct 79)		20 (Mar 80)	
Oklahoma City		25 (Mar 80)	16 (Sep 80)	
Los Angeles		25 (Mar 80)		15 (May 80)* 20 (Oct 80)
Washington, D.C.	0	0	11 (June-Jul 81)	33 (June-Jul 81)

*Machines were faulty and were all returned for repair.

3-4 MAINTENANCE. The maintenance history below indicates that maintenance on both machines was excessive compared to the desired reliability.

a. Elinfa Maintenance. Sixty-nine participants used Elinfa machines for periods of four to nine months. During 26 months of service, 67 repairs were made to 37 of 54 machines available for the study. This is approximately 2.6 repairs per month. Table 3-4 below shows the repair frequency and indicates that three-fourths of the machines required repair.

Table 3-4. Elinfa Repair Frequency

Machine Quantity		Times Repaired		Total Repairs
3	X	4	=	12
6	X	3	=	18
9	X	2	=	18
19	X	1	=	19
17	X	0	=	0
Totals 54				67

Of the 67 repairs, 36 were pin drive mechanism problems. Another major problem was that the machine would not read the tape. This problem was mostly associated with head alignment, or the multifunction board being loose as a result of handling of the machine. There were several cases where a pin adjustment was required after the head was adjusted.

The pin drive mechanism requires a time consuming factory repair. For example, a three pin repair costs $69.54 @ one hour per pin labor, $6.00 for two-way shipping between Virginia and Florida and $15.00 for round trip insurance coverage (value @ 3K), for a total repair cost of $90.54. This is indicative of

what to expect with the Elinfa design. This would not be acceptable because down time for the user would be too long and repair costs would be excessive.

b. VersaBraille Maintenance. Fifty-three participants used VersaBraille machines over a ten month period. During this time, 20 repairs were made to 15 machines (does not include the 15 machines returned at the start of the program in May 1980). This rate is approximately two repairs per month. Table 3-5 below shows the repair frequency and indicates that all machines required repairs.

Table 3-5. VersaBraille Repair Frequency

Machine Quantity		Times Repaired		Total Repairs
2	X	3	=	6
1	X	2	=	2
12	X	1	=	12
37	X	0	=	0
Totals 52				20

Nine machines were returned because of pin problems and five machines were returned because they would not read. These latter machines may have had pin problems also.

The cost of repairs is not known because all repair work was done under a warranty, but it is expected that they are equivalent to Elinfa repair cost. All repairs would have to be done at the factory in Palo Alto, which will result in excessive shipping costs. This situtation would probably not be acceptable because down time for the user would be too long and repair cost would be excessive.

3-5 EFFECT OF MAINTENANCE ON DISTRIBUTION. The brief history below indicates major maintenance problems and the effect that they had on distribution.

a. Elinfa Machines. When the program was started in September of 1979, NLS had approximately 55 machines in storage. The NLS staff determined that these machines were not suitable for distribution and they were returned to Elinfa for adjustment of the pin height in the display and for a quality control check.

On January 14, 1980, VSE received 25 of these machines from NLS which had been returned to Elinfa by NLS for repair. Three of these machines were again returned to Elinfa because they did not operate properly. Two machines had uneven braille display and one had a transport problem.

The first Elinfa was delivered to a participant in Baltimore on January 21, 1980. The other machines were delivered to Baltimore participants in February 1980. On March 4, 1980, additional machines were picked up directly from Elinfa which gave VSE a total of 45 machines for distribution.

Delivery of Elinfa machines to the Little Rock, Arkansas participants was begun on March 12, 1980.

In August 1980, the availability of the VersaBraille for use in Oklahoma City was still not known. A decision was made to collect the Elinfa machines from Baltimore and redistribute them in Oklahoma City. This was done in September 1980.

b. VersaBraille Machines. In January 1980, NLS was informed by TSI, the VersaBraille manufacturer, that 24 machines would be delivered on March 31, 1980 and an additional 25 machines by April 21, 1980. These were to be used in Los Angeles and Oklahoma City. The first 15 were shipped to VSE's Oxnard, California office the first week of May 1980, and the remainder of the machines were shipped as they became available. During the week of May 12, 1980, delivery to the Los Angeles participants was started.

Prior to delivery, the machines were tested using a built-in automated test procedure to check the pins in the display. An internal program in the machine brings up each pin, one at a time. This test indicated that a number of machines had faulty pin displays. Since it was not clear whether the fault was in the display or in the automated test program, distribution of the machines was commenced. The participants who read with the first 15 machines in the first two weeks of use confirmed that 12 machines had a pin problem, which indicated that the automated test program was reliable and the machines were at fault. A decision was made to return all the machines to TSI and stop the scheduled delivery.

TSI confirmed that there was a problem with the mechanism that drove the pins and that some research would be necessary to resolve it. As a result, delivery of all VersaBraille machines was put on an indefinite hold and a decision was made to put the Baltimore Elinfa machines in Oklahoma City instead of the scheduled VersaBraille. Toward the end of September 1980, TSI advised that they had solved the problem associated with the pin drive mechanism. Delivery of the VersaBraille machines to the Los Angeles participants was scheduled for the last week in October 1980.

3-6 COST. The cost of Elinfa machines used in the study was $1,600 each. The cost of the VersaBraille machines used in the study was approximately $4,350 each.

Section II. CASSETTE TAPES

3-7 SCOPE. Following is a discussion of why particular reading materials were selected, how the material was programmed, how master tapes and copies of the master were made, how the tapes were distributed, and associated costs.

3-8 SELECTION OF READING MATERIAL. Magazines were chosen for the evaluation since they provide a continuing source of new reading material that can be easily transferred to cassette tape. The National Library Service selected Clovernook (Home and School for the Blind, located in Cincinnati, Ohio), a major paper braille magazine producer, to make the master tapes. Many participants were reading the paper braille magazines selected for the study prior to the start of the program. This reduced the effect of the reading material on the evaluation. Since each of the machine being used in the program requires input in a different format, the machine manufacturer had to furnish an interface between the Clovernook computer and the recording equipment. Manufacturers of each machine were responsible for duplicating cassette copies of the magazines selected.

Magazines selected for this program covered a wide range of topics to satisfy the interest of all participants who were selected to represent a wide cross section of readers with respect to age, sex and education level.

The following magazines were chosen:

- Braille Variety News. Selected reprints from such magazines as Photoplay and TV-Mirror on celebrities and musical groups.

- Playboy. Spotlights current fashions and controversies. Includes interviews with celebrities, short fiction, reviews, letters and advice on etiquette.

- Family Health. Advice from experts on the latest medical discoveries. Contains articles on preventing illness through diet and exercise, and information on maintaining emotional well-being.

- Better Homes and Gardens. Practical advice on home and money management, how-to-do-it home plans, and decorating ideas.

- Popular Mechanics. Pratical advice for the handyman, information on automotive and home repairs, and features on new equipment. (Shortly after the program was initiated, Popular Mechanics was dropped because formatting and dimensional terminology were not compatible with the current software program.)

- Psychology Today. Scientific articles on all aspects of psychology. Usually features an interview with a psychologist.

3-9 PROGRAMMING. The Elinfa and the VersaBraille systems use different digital formats to record data on tape. Two special software programs written for NLS by Joe Sullivan of Duxbury Systems were designed to transfer information from the computer to the Elinfa and VersaBraille systems.

3-10 MASTER TAPE. Master tapes for this program were made at Clovernook, who has a contract with NLS to produce paper braille for these magazines. The following sequence is used to make the master tapes:

1. Material is manually typed into computer (the operator inserts special instructions with regard to braille format).

NOTE

A new system has been put into service where the material is scanned by an optical reader and put directly into the computer.

2. Computer program converts text material into Grade two braille (similar to shorthand).

3. Paper copy of braille text is printed for proofreading.

4. Corrected text is reprinted in braille and proofread a second time. Necessary corrections are made by computer operator and text material is approved. The text material is then ready for making the master cassette tape.

a. Elinfa. The Elinfa can input data at the rate of 300 Baud. It takes 1-1/2 hours to encode one side of a C-90 cassette. The computer operator inserts a blank cassette in the Elinfa system, starts the computer and the Elinfa machine, and records the master. The Clovernook computer stops inputting data when one side of a cassette is full. This operation is repeated for as many sides as are required by a magazine.

The paper braille index is a supplement to the cassette. It was also produced at Clovernook. It was found that the computer count of where articles were located was inaccurate by as many as 25 counter numbers from the beginning of an article. Therefore, a printed copy of the Table of Contents was supplied with the master tape to Elinfa, who verified and/or corrected the counter numbers.

Initially, the software program did not properly use available space on the 20-cell line. As a result, if three words (including the two blank spaces) required 24 cells, the last four cells were dropped and not picked up in the next line. This required a change in the Clovernook software program to anticipate the space requirement and divide the line so that only complete words would appear on the display.

b. VersaBraille. Prior to making the master tape, a blank cassette was formatted. Formatting divides each side of a tape, one side at a time into 200 pages, where each page contains space for 1000 braille cells. Formatting required approximately 15 minutes per side for C-60 cassettes and is an automatic process.

Making the master tape requires using a VersaBraille Model P-1 (modified) which inputs data at 1200 Baud and required approximately 40 minutes to complete one side of a cassette. This master tape has an index on it, but requires refinement at a later date before it can be used effectively. Therefore, a paper copy of the index was supplied to TSI with each master tape.

The first problem arose when the VersaBraille would not accept data from the computer and rejected the cassette from the machine. The VersaBraille is designed to accept or search for data using a key word title that does not exceed 10 braille characters. The cause of the problem was identically abbreviated titles, which the VersaBraille will not accept. Magazines which start with the magazine name, followed by a subject in the magazine, are a particular problem. This problem was resolved by the computer operator inserting a number before each title.

The second problem involved the number of characters allowed on a page, which is 1000. When data is entered by an operator, the VersaBraille is designed to accept 950 characters and then sound a warning. At 980 characters two warnings are sounded and at 1000 characters a tone is sounded which tells the operator that the page is full and to proceed to the next page. The problem was that many articles in Better Homes and Gardens end with between 980 and 1000 characters on a page.

A temporary solution was to change the software program so that it inserted extra blanks into the program which extended the article to the next page. The VersaBraille microprocessor which controls these operations was programmed to handle this situation.

3-11 TAPE COPIES. Each equipment supplier was responsible for duplicating his own tapes. The process for each machine is described below.

a. Elinfa. Initially, the master tapes were sent to the Elinfa office in Washington, D.C. for duplication. When the business was sold, the duplicating operation was transferred to Triformation Systems in Stuart, Florida. Triformation Systems used the same duplicating method that was being used in Washington. This method is described below.

Tapes are duplicated on three Nakamichi tape recorders, one to play the master and two others to record the two copies at a normal speed of 1-7/8 inches per second. The operation is slow but does not require much operator time. It takes approximately 45 minutes to duplicate one side of a C-90 cassette. This procedure is repeated until sufficient copies have been made.

A paper braille index is used to locate material. The system counter indicates the number of payoff reel revolutions at the beginning of a given article. As part of the duplication process, the locations of articles are checked against the counter to verify them for the index. This is done by playing the tape on a Digicassette, which had audio capability. The operator listens for the 10-second break which separates the articles on the tape. The exact location of the beginning of the article is then found using the machine counter. These counter numbers are recorded and returned to Clovernook. The Clovernook computer operator recalls the index for the particular magazine on the CRT screen and inserts the correct counter numbers for the appropriate article. A paper copy of the index is then made and forwarded to NLS for duplication on their thermoform equipment. Copies of the cassettes were sent by Triformation to VSE Corporation.

b. VersaBraille. These tapes are duplicated by Telesensory Systems, Incorporated, Palo Alto, California. Prior to duplication, the master tape must be indexed. When the master tape is received by TSI, the original magazine contents are read and the 10-character word which best describes the article is chosen. This word is then inserted on the tape in the abbreviated index. At this time, TSI also edits the entire magazine table of contents.

The master tape is then ready for duplication. Because this is an exact duplication process, the tape does not have to be formatted. The tape is duplicated in a Telex-300 duplicator which makes up to eight duplicates at one time, eight times faster than the original tape speed. It requires approximately four minutes to duplicate a C-60 cassette which normally runs for 30 minutes.

3-12 DISTRIBUTION. After the Elinfa tapes were duplicated, they were sent in bulk to VSE. VSE labeled the cassettes and made stick-on xerox labels with the address of the participants. The tapes and labels were then sent to NLS. NLS added the thermoform index for each tape and labeled and stuffed the mailing envelopes. The tapes were mailed as free matter for the blind. The only function performed by VSE for the VersaBraille System was to supply the address labels. TSI labeled and mailed the tapes from Palo Alto.

3-13 FAULTY TAPES. The quality control check (para 3-15) identified several tape problems. They were:

- Voltage fluctuation in the Elinfa system which resulted in dropouts in the master tape. This problem was resolved by installing a re-designed charging system to correct the voltage fluctuation.

- Some Elinfa tapes had blocks of information that would not read. The recording level of the duplicating equipment was not compatible with the master. This problem was resolved by comparing the master tape signal with the duplicated tape on an oscilloscope and adjusting the duplicating equipment signal to match the master tape.

- Several Elinfa tapes had a garbled output at the end of side A, or at the beginning of side B. The problem was caused by wrinkles on the tape which distorted the signal.

3-14 COST. NLS has estimated that the cost of the blank cassette plus the duplication cost for the talking book program is $1.25 per cassette and expects to pay $1.50 for similar items for cassette braille.

Clovernook has provided cost information for the production of paper braille magazines. This includes the cost associated with the automatic scanning of printed matter into a braille format master. Assuming the "master" cost to be the same for cassette braille, the estimated cost for cassette braille can be compiled and is shown in Table 3-6.

TABLE 3-6

PRODUCTION COST OF PAPER MAGAZINE vs. CASSETTE BRAILLE MAGAZINE

MAGAZINE	PAPER BRAILLE MAGAZINE					CASSETTE BRAILLE MAGAZINE		
	No. Copies per Month	Pages Per Copy	Cost Per Copy (Dollars)	% Cost to Produce Master	Cost of Master (Dollars)	Cost of Master (Dollars)	Cost of Cassette Plus Duplication (Dollars)	Cost per Copy (Dollars)
Playboy	1150	467	7.19	37	2.66	2.66	1.50	4.16
Psychology Today	1075	235	4.45	29	1.29	1.29	1.50	2.79
Better Homes & Gardens	1350	271	4.59	25	1.15	1.15	1.50	2.65
Family Health	1350	134	2.27	31	0.07	0.70	1.50	2.20
New York Times*	2100	97	1.44	24	0.35	0.35	1.50	1.85
Ladies Home Journal*	2300	235	4.35	23	1.00	1.00	1.50	2.50
Childrens Digest*	475	72	1.97	54	1.06	1.06	1.50	2.56

* Based on information obtained from a study produced by Exotech and Clovernook projections

Section III. QUALITY CONTROL

3-15 QUALITY CONTROL REQUIREMENTS. When the first Elinfa tapes were delivered to VSE for distribution to the Baltimore, Little Rock, Oklahoma City, and Washington, D.C. participants, VSE performed a survey check and found many of the tapes to be faulty. VSE then assigned a braille reader to check all tapes prior to distribution. In anticipation of similar problems with VersaBraille tapes, VSE hired a braille reader in Los Angeles to perform the same functions for tapes being distributed there. Both readers were retained throughout the study which kept most of the faulty tapes from reaching the participants.

Section IV. PARTICIPANT SELECTION

3-16 GEOGRAPHIC LOCATIONS. The original intent of the program was to select 20 to 25 participants from four geographical locations: Baltimore, Maryland; Little Rock, Arkansas; Oklahoma City, Oklahoma; and Los Angeles, California. These sites were chosen because of the concentration of braille readers.

Regional libraries in these areas were asked to submit a list to NLS of approximately 50 current braille readers who might be interested in participating in the program. VSE was provided with a copy of the list from NLS and made the initial contact by letter. VSE asked those interested in participating to contact them by mail or to call collect.

Responses from all areas were approximately 50 percent. Those who responded were asked if they would participate and were told that they would be contacted when the program was ready to begin. To obtain the desired number of participants in Oklahoma City and Los Angeles, it was necessary for VSE to contact people by telephone who had not responded to the initial letter. This effort resulted in bringing a few more people into the program.

3-17 SELECTION OF PARTICIPANTS. The original intent was to select people with varied backgrounds and to obtain an age grouping of 30 percent under 25, 30 percent between 25 and 40, and 40 percent between 40 and 65. Because of the limited response the desired age spread was not obtained. Table 3-7 is a summary of the actual age groupings obtained. The arithmetic mean of the population age is 37.

Table 3-7. Summary of Participant Age Groups

Age Category	All Cities		Baltimore		Little Rock		Oklahoma City		Los Angeles		Washington D.C.	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Under 25 years	16	14	3	16	2	10	0	0	3	15	8	18
25 - 39 years	63	53	11	58	13	65	6	38	10	50	23	52
40 - 65 years	36	30	5	26	4	20	8	50	6	30	13	30
Over 65 years	4	3	0	0	1	5	2	12	1	5	0	0

The desired sex distribution was 50/50. Actual distribution was 55 percent female and 45 percent male.

Many of the potential participants under 25 were in school and did not feel that they could devote the necessary time to the program. Also, the selection of reading material was not what younger people enjoy reading.

It became apparent that there was a direct correlation between education levels and the desire to participate in the program. Therefore, the participant group for the program had a higher average education level than the general braille-reading public. Table 3-8 below is a summary of participant education levels.

Table 3-8. Summary of Participant Education Levels

Education	Participant Quantity	Percent of Total
Grade School	1	1
High School	25	22
1-4 Years College	27	23
Bachelor's Degree	38	33
Master's Degree	18	15
Doctorate	7	6

Section V. PARTICIPANT INVOLVEMENT

3-18 PARTICIPANTS' INTRODUCTION. When a machine was delivered to a participant, the sequence of events and the reasons for them were explained. The events and participant performance are presented in the following paragraphs.

3-19 PRE-READING TEST. A pre-reading test was given to each participant to determine his reading speed and comprehension using paper braille. For reading speed, the participant read 1720 words of the book "Earthquakes, A National History," (chapter one, "Our Trembling Earth") by D.D. Halacy, Jr., while being timed with a stop watch. For comprehension, the participant answered five questions about the material. Each question had three possible answers. The interviewer recorded the participants answer on the data sheet. The average reading speed for this test was 115 WPM. Eighty percent of the questions were answered correctly.

3-20 MACHINE INSTRUCTION. After the reading test, the participant was instructed for approximately 1-1/2 hours in machine use. The participant was given an empty machine, and the location and function of each control was pointed out. The participant was then given a tape and was shown how to read using the machine. When this was mastered, he was instructed on how to use the accompanying index and how to find the material on the tape. A braille instruction manual was left with each participant. Each of the participants was given a telephone number with instructions to call collect if they had a problem.

3-21 PERFORMANCE LOG. Each participant was asked to keep a monthly performance log which indicated titles of articles read, time spent reading, and any problems experienced. Preaddressed stamped envelopes were supplied and instruction given to mail the log to VSE bi-monthly. Approximately 10 percent sent in detailed logs as requested. Approximately 50 percent sent in logs which only indicated the amount of time spent reading. The other participants sent no logs at all.

A VSE representative was sent to Baltimore and Little Rock to encourage participants to maintain and mail their logs. This effort was non-productive and even caused a few participants to drop out of the program.

3-22 POST-READING TEST. A post-reading test was given to each participant when the machine was picked up, to compare reading speed and comprehension between paper braille and cassette braille. The post-test was divided into two parts. The first part was approximately 1260 words and the second part was approximately 970 words. The post-test was given so that half of the participants read the first part on paper and the second on the machine. The other half read the machine first and the paper second. There were three questions for each part which were answered after reading each part. Questions and answers were in paper braille and the participant gave his answer to the interviewer who recorded it. Summaries of participant performance are given in Tables 4-1 through 4-6 (pgs 4-5 through 4-11).

The test provided reading speed and comprehension data for cassette and paper braille. A proficiency rating was then established by multiplying the reading speed by the number of correct answers. The highest proficiency rating was assigned a value of 100 and all other participants were rated as a percentage of this value. A percent efficiency of cassette braille reading was calculated. The percent Efficiency Reading Time was determined by dividing the cassette speed by paper speed. The percent Efficiency-Comprehension was determined by multiplying the reading

time by the number of correct answers for paper divided by the number of correct answers for paper. The average reading speed for paper braille was 89 wpm and 68 percent of the questions were answered correctly. The average for cassette braille was 71 WPM and 68 percent of the questions were answered correctly.

3-23 INTERVIEW AND QUESTIONNAIRE. Following the post-reading test, the participant completed a questionnaire and expressed other related comments as desired.

The same questionnaire was given to all participants regardless of which machine they had used. The first group of questions relates to the reader's opinion of cassette braille versus paper braille. The second group of questions relates to specific features of the machine. The results of the questionnaire are presented in PART II, Section II.

Section VI. EVENT SUMMARY

Sept 79
- Contract awarded 9/28/79
  - NLS in possession of 55 Elinfa Machines, but returned them to Elinfa for adjustment
  - VersaBraille and Braillocord not available

Nov 79
- Problem making master tapes for Elinfa solved at Clovernook by Trediakoff of Elinfa and Sullivan of Duxbury System by changing the computer program

Dec 79
- Paper index produced by Clovernook computer did not agree with actual location of chapters on the tape. Index manually prepared from master tape
- Received list of prospective Baltimore participants - Mailed 45 letters, received 22 responses

Jan 80
- Selected 20 Baltimore participants
- Rewrote Elinfa Operating manual
- Sent 39 letters to prospective Little Rock participants
- Received 25 Elinfa machines from NLS
- Started machine deliveries to Baltimore
- NLS ordered 50 VersaBrailles

Feb 80
- 15 Elinfa machines were delivered to Baltimore
- 19 positive responses from Little Rock
- Index errors continue to be a problem with the Elinfa magazines

Mar 80
- 5 Elinfa machines delivered to Baltimore
- 20 Elinfa machines delivered to Little Rock
- Mailed 44 letters to prospective Los Angeles participants with 18 responses
- Elinfa master tape production problem at Clovernook determined to be an inadequate power supply in the Elinfa equipment
- Elinfa index continues to be inaccurate

Apr 80
- Problem with Elinfa machines in field - found to be a spacer missing, causing a circuit board to come loose
- Mailed letters to 26 prospective participants in Oklahoma City, with 9 responses. Supplemented list by obtaining information from Clovernook to obtain 26 names
- Display problems start occurring in field machines
- No indexes for Elinfa magazines (Work overload at Clovernook)

May 80
- Started distribution of VersaBrailles in Los Angeles. Display problems developed immediately - all machines returned to TSI
- Los Angeles and Oklahoma City put on hold

Jun 80
- Elinfa became part of Triformation Systems and operations moved to Stuart, Florida from Washington, D.C.
- 6/20/80 - contract extended to 3/31/81

Jul 80
- Visited Baltimore and Little Rock to encourage participants to provide better logs. Four participants dropped out of the program during these visits

Aug 80
- VersaBraille machines still on hold
- Decision to pull Elinfa machines in from Baltimore for placement in Oklahoma City
- Final questionnaire approved by NLS
- Repair record for Elinfa increased from 22 to 55% as a result of machines needing repairs when picked up from Baltimore

Sep 80
- Delivered 16 Elinfa machines to Oklahoma City
- Elinfa indicated display problems were caused by problems similar to TSI's

Oct 80
- Delivered 20 VersaBrailles to Los Angeles
- TSI service representative sent to Los Angeles to repair machines so all participants had a functioning machine when TSI representative left
- Six of sixteen Elinfa machines left in Oklahoma City had to be returned for repair
- Inaccuracies occur again in Elinfa indexes

Nov 80
- Baltimore participants administered Final Questionnaire.
- Some VersaBraille machines will not read all tapes - TSI investigating problem

Dec 80
- Picked up Elinfa machines from Little Rock
- Decision made to include Washington, D.C. area
- Braillocord dropped from program, no means to produce braille cassettes
- Problem with VersaBraille not recording masters of some magazines

Jan 81	• Mastering problem with VersaBraille solved by modifying computer program • Delivered five VersaBrailles to Baltimore; these participants had used the Elinfa machines • Elinfa machines modified with the option of using a pushbutton switch to advance the line • New problems making VersaBraille masters tapes; cause unknown
Feb 81	• Picked up machines from Oklahoma City • VersaBraille master tape problems continue
Mar 81	• Lists of prospective Washington, D.C. area participants obtained • VersaBraille master tape problems continue • Modified Elinfa machines not received
Apr 81	• VersaBraille machines picked up from Los Angeles • Forty participants in Washington area agree to participate • Joe Sullivan went to TSI and resolved the VersaBraille mastering problem • Received modified Elinfa machines • Problem scheduling Washington, D.C. participants - can often only see one person a day • April 1, 1981 - Contract extended to December 31, 1981
Jul 81	• 33 VersaBraille and 11 Elinfa in Washington, D.C. area • Magazine production of Elinfa magazine very slow • Magazine production for VersaBraille on time with no problems
Aug 81	• Stopped VersaBraille magazine production • Elinfa magazine production still very slow • Elinfa machines not holding a charge
Sep 81	• Started picking up equipment from Washington, D.C. • Visited Clovernook to get master production cost information
Oct - Nov 81	• Submitted partial draft of report to NLS

PART IV. SUPPORTING DOCUMENTATION

Section I. INDIVIDUAL CITY DATA SHEET TABLES

NOTE

Individual participant data sheets are contained in two CONFIDENTIAL addendums to this report:

- Completed Questionnaire From the Elinfa Participants, December 31, 1981
- Completed Questionnaire From the VersaBraille Participants, December 31, 1981

Elinfa Machine

Table 4-1. Reading Speed and Comprehension Results, Post-Test, Baltimore

PARTICIPANT	READING SPEED (words per minute)		COMPREHENSION maximum score 3 per each part		PROFICIENCY[1] RATING		% EFFICIENCY OF CASSETTE BRAILLE[2]	
	Cassette	Paper	Cassette	Paper	Cassette	Paper	Reading Time	Comprehension
1	97	140	3	3	69	100	69	69
2	115	139	1	2	27	66	82	41
3	88	115	2	2	43	55	79	78
4	88	115	3	3	64	82	79	78
5	88	114	3	3	64	82	79	78
6	97	97	1	2	23	46	100	50
7	88	97	2	1	43	23	93	187
8	61	90	1	2	14	43	67	32
9	49	90	2	1	24	21	56	114
10	79	88	2	3	38	64	88	59
11	57	81	3	2	41	38	73	108
12	49	81	1	1	12	19	60	63
13	70	75	1	2	17	35	94	49
14	63	75	2	3	30	53	85	57
15	63	69	2	2	30	33	90	91
16	57	37	3	2	41	18	154	228
17	32	36	2	2	15	17	90	88

[1]Based on 100 percent for the best combination of time and score.

[2]Based on 100 percent for paper braille reading time and proficiency rating.

Elinfa Machine

Table 4-2. Reading Speed and Comprehension Results, Post-Test, Little Rock

PARTICIPANT	READING SPEED (words per minute)		COMPREHENSION maximum score 3 per each part		PROFICIENCY[1] RATING		% EFFICIENCY OF[2] CASSETTE BRAILLE	
	Cassette	Paper	Cassette	Paper	Cassette	Paper	Reading Time	Comprehension
1	97	229	1	1	23	54	42	43
2	120	194	2	2	57	91	67	63
3	88	140	1	3	21	100	63	21
4	*	126	*	3	-	90	*	-
5	78	114	2	2	37	54	68	69
6	90	108	2	2	43	51	83	84
7	81	105	3	3	58	75	77	77
8	72	88	3	1	51	21	82	243
9	69	74	1	0	16	-	93	-
10	40	74	**	2	-	35	54	-
11	72	69	3	2	51	33	104	155
12	45	69	2	1	21	16	65	131
13	57	60	3	2	41	29	95	141
14	30	30	**	**	-	-	77	-
15	25	33	**	**	-	-	76	-
16	28	26	**	**	-	-	108	-
17	20	25	**	**	-	-	80	-
18	16	19	**	**	-	-	84	-
19	21	18	**	**	-	-	117	-

* Machine would not function for participant

** Reading speed determined by reading only a portion of the article

[1] Based on 100% for the best combination of time and score

[2] Based on 100% for paper braille reading time and proficiency rating

Elinfa Machine

Table 4-3. Reading Speed and Comprehension Results, Post-Test, Oklahoma City

PARTICIPANT	READING SPEED (words per minute)		COMPREHENSION maximum score 3 per each part		PROFICIENCY[1] RATING		% EFFICIENCY OF CASSETTE BRAILLE[2]	
	Cassette	Paper	Cassette	Paper	Cassette	Paper	Reading Time	Comprehension
1	84	134	2	3	42	100	63	42
2	88	133	3	3	66	99	66	67
3	81	133	1	1	20	33	61	61
4	69	120	1	3	17	90	58	19
5	101	111	3	2	76	55	91	136
6	58	106	1	2	15	53	55	28
7	72	75	3	1	54	19	96	284
8	56	69	*	*	-	-	81	-
9	53	60	2	3	26	45	88	56
10	57	58	3	2	43	29	98	148
11	37	40	*	*	-	-	93	-
12	42	38	*	*	-	1	110	-
13	25	26	*	*	-	-	96	-

*Reading speed determined by reading only a portion of the article.

[1]Based on 100% for the best combination of time and score.

[2]Based on 100% for paper braille reading time and proficiency rating.

Table 4-4. Reading and Comprehension Proficiency and Efficiency Ratings, Washington, D.C., Elinfa

PARTICIPANT	READING SPEED (words per minute)		COMPREHENSION maximum score 3 per each part		PROFICIENCY[1] RATING		% EFFICIENCY OF CASSETTE BRAILLE[2]	
	Cassette	Paper	Cassette	Paper	Cassette	Paper	Reading Time	Comprehension
1	133	185	3	2	108	100	72	108
2	67	100	1	2	18	54	67	34
3	76	97	2	1	41	26	78	156
4	75	88	3	2	61	48	85	128
5	65	81	1	1	18	22	80	80
6	57	78	-	-	-	-	73	-
7	49	70	-	-	-	-	70	-
8	63	67	-	-	-	-	94	-
9	56	62	-	-	-	-	90	-
10	39	55	-	-	-	-	71	-
11	25	32	-	-	-	-	78	-

[1]Based on 100 percent for the best combination of time and score.

[2]Based on 100 percent for paper braille reading time and proficiency rating.

VersaBraille Machine

Table 4-5. Reading Speed and Comprehension Results, Post-Test, Los Angeles

PARTICIPANT	READING SPEED (words per minute)		COMPREHENSION maximum score 3 per each part		PROFICIENCY[1] RATING		% EFFICIENCY OF CASSETTE BRAILLE[2]	
	Cassette	Paper	Cassette	Paper	Cassette	Paper	Reading Time	Comprehension
1	174	192	3	3	91	100	91	91
2	100	184	3	2	52	64	54	81
3	67	180	1	2	12	63	37	19
4	153	176	1	1	27	31	67	87
5	121	168	1	3	21	88	72	24
6	126	149	1	1	22	26	85	85
7	132	138	3	2	69	48	96	144
8	83	133	3	3	43	69	62	62
9	120	121	1	1	21	21	99	100
10	83	115	3	3	43	60	72	72
11	315	102	1	2	55	18	308	305
12	79	97	3	1	41	17	81	241
13	72	95	2	1	25	16	76	156
14	80	90	1	2	14	31	89	45
15	69	79	2	2	24	27	87	89
16	79	65	2	3	27	34	122	79
17	59	55	-	-	-	-	107	-
18	40	35	-	-	-	-	114	-
19	25	22	-	-	-	-	113	-

[1]Based on 100 percent for the best combination of time and score.

[2]Based on 100 percent for paper braille reading time and proficiency rating.

VersaBraille Machine

Table 4-6. Reading Speed and Comprehension Results, Post-Test, Washington, D.C.

PARTICIPANT	READING SPEED (words per minute)		COMPREHENSION maximum score 3 per each part		PROFICIENCY[1] RATING		% EFFICIENCY OF CASSETTE BRAILLE[2]	
	Cassette	Paper	Cassette	Paper	Cassette	Paper	Reading Time	Comprehension
1	185	315	2	2	59	100	59	59
2	123	169	2	3	39	80	73	55
3	133	163	1	1	21	26	82	82
4	174	149	3	2	83	47	117	175
5	110	130	3	3	52	62	85	85
6	101	130	2	2	32	41	78	78
7	90	129	3	1	43	20	70	210
8	84	126	3	2	40	40	67	100
9	101	125	3	3	48	60	81	81
10	105	120	2	3	33	57	88	59
11	92	116	-	-	-	-	-	-
12	75	114	3	3	36	54	66	66
13	100	112	3	1	48	31	89	267
14	94	105	2	2	30	33	90	90
15	95	99	3	3	45	47	96	96
16	80	97	3	2	38	18	82	123
17	74	95	3	2	35	30	78	117
18	86	92	1	2	14	29	93	46
19	83	92	1	2	13	29	90	45
20	65	84	3	3	31	40	77	77
21	64	84	2	0	20	0	76	0
22	61	83	3	3	29	40	73	73
23	73	82	0	2	0	26	89	0
24	56	78	-	-	-	-	72	-
25	53	70	0	3	0	33	76	0
26	45	67	-	-	-	-	67	-
27	44	57	-	-	-	-	77	-
28	53	53	-	-	-	-	100	-
29	24	31	-	-	-	-	77	-
30	24	28	-	-	-	-	86	-
31	33	26	-	-	-	-	122	-

[1]Based on 100 percent for the best combination of time and score.

[2]Based on 100 percent for paper braille reading time and proficiency rating.

Table 4-7. Participants' Reactions to Concept, Baltimore

	Prefer Cassette Braille	Prefer Paper Braille	No Preference
1. Ability to initially locate specific articles.	1	18	1
2. Ability to skim material - both forward and backward.	2	17	1
3. Space requirements for braille material.	19*	-	-
4. For reading speed.	3	12	4
5. For reading comprehension.	2	9	8
6. Missing or unreadable characters or words.	2	10	7
7. If you are reading for short periods of time (30 minutes or less).	6	8	6
8. If you are reading for long periods of time (30 minutes or more).	4	11	3
9. Produces less fatique.	3	10	5
10. Ability to maintain your place while reading.	7	6	6

11. Would conversion by The Library from paper braille to a cassette braille system, cause a problem for you? 7 yes 11 no.

12. With a reading machine, would you prefer to read magazines or books? 8 books 3 magazines 7 both.

* Not all of the participants answered all of the questions, therefore the totals for all of the questionnaires will vary.

Table 4-8. Participants' Reactions to Concept, Little Rock

	Prefer Cassette Braille	Prefer Paper Braille	No Preference
1. Ability to initially locate specific articles.	4	14	1
2. Ability to skim material - both forward and backward.	1	18	-
3. Space requirements for braille material.	19	-	-
4. For reading speed.	4	13	2
5. For reading comprehension.	3	5	11
6. Missing or unreadable characters or words.	4	6	8
7. If you are reading for short periods of time (30 minutes or less).	9	4	5
8. If you are reading for long periods of time (30 minutes or more).	6	9	3
9. Produces less fatique.	5	10	4
10. Ability to maintain your place while reading.	14	3	2

11. Would conversion by The Library from paper braille to a cassette braille system, cause a problem for you? 5 yes 13 no 1 no preference

12. With a reading machine, would you prefer to read magazines or books? 6 books 6 magazines 7 both.

Table 4-9. Participants' Reactions to Concept, Oklahoma City

	Prefer Cassette Braille	Prefer Paper Braille	No Preference
1. Ability to initially locate specific articles.	-	9	2
2. Ability to skim material - both forward and backward.	3	7	1
3. Space requirements for braille material.	11	-	-
4. For reading speed.	4	6	1
5. For reading comprehension.	1	4	6
6. Missing or unreadable characters or words.	3	5	2
7. If you are reading for short periods of time (30 minutes or less).	8	2	1
8. If you are reading for long periods of time (30 minutes or more).	5	3	2
9. Produces less fatique.	4	6	1
10. Ability to maintain your place while reading.	4	4	3

11. Would conversion by The Library from paper braille to a cassette braille system, cause a problem for you? 1 yes 10 no.

12. With a reading machine, would you prefer to read magazines or books?
3 books 2 magazines 6 both.

Table 4-10. Participants' Reactions to Concept, Los Angeles

	Prefer Cassette Braille	Prefer Paper Braille	No Preference
1. Ability to initially locate specific articles.	6	8	5
2. Ability to skim material - both forward and backward.	7	7	5
3. Space requirements for braille material.	19	-	-
4. For reading speed.	5	10	4
5. For reading comprehension.	1	7	11
6. Missing or unreadable characters or words.	4	5	10
7. If you are reading for short periods of time (30 minutes or less).	4	6	9
8. If you are reading for long periods of time (30 minutes or more).	4	12	3
9. Produces less fatique.	2	14	3
10. Ability to maintain your place while reading.	9	2	8

11. Would conversion by The Library from paper braille to a cassette braille system, cause a problem for you? 5 yes 14 no.

12. With a reading machine, would you prefer to read magazines or books? 6 books 2 magazines _____ both 10 no preference.

Table 4-11. Participants' Reactions to Concept, Washington, D.C. (Elinfa)

	Prefer Cassette Braille	Prefer Paper Braille	No Preference
1. Ability to initially locate specific articles.	1	10	-
2. Ability to skim material - both forward and backward.	2	9	-
3. Space requirements for braille material.	11	-	-
4. For reading speed.	4	6	1
5. For reading comprehension.	3	4	4
6. Missing or unreadable characters or words.	2	3	6
7. If you are reading for short periods of time (30 minutes or less).	4	4	3
8. If you are reading for long periods of time (30 minutes or more).	3	7	1
9. Produces less fatique.	3	6	1
10. Ability to maintain your place while reading.	8	3	-

11. Would conversion by The Library from paper braille to a cassette braille system, cause a problem for you? 6 yes 5 no.

12. With a reading machine, would you prefer to read magazines or books? 6 books 1 magazinee 4 both.

Table 4-12. Participants' Reactions to Concept, Washington, D.C. (VersaBraille)

	Prefer Cassette Braille	Prefer Paper Braille	No Preference
1. Ability to initially locate specific articles.	12	16	4
2. Ability to skim material - both forward and backward.	13	13	6
3. Space requirements for braille material.	31	1	-
4. For reading speed.	10	14	8
5. For reading comprehension.	4	6	22
6. Missing or unreadable characters or words.	15	4	13
7. If you are reading for short periods of time (30 minutes or less).	10	9	13
8. If you are reading for long periods of time (30 minutes or more).	11	12	8
9. Produces less fatique.	7	14	9
10. Ability to maintain your place while reading.	20	5	5

11. Would conversion by The Library from paper braille to a cassette braille system, cause a problem for you? 9 yes 23 no.

12. With a reading machine, would you prefer to read magazines or books? 4 books 9 magazines 19 both.

Table 4-13. Participants' Reactions to Concept, Comparison of Elinfa and VersaBraille Users

	Participants Response in Percent					
	Elinfa Users			VersaBraille Users		
	Preference			Preference		
	Cassette	Paper	None	Cassette	Paper	None
1. Ability to initially locate specific articles.	10	84	6	35	47	18
2. Ability to skim material - both forward and backward.	13	84	3	39	39	22
3. Space requirements for braille material.	100	-	-	98	2	-
4. For reading speed.	25	62	13	29	47	24
5. For reading comprehension.	15	37	48	10	26	64
6. Missing or unreadable characters or words.	19	41	40	37	18	45
7. If you are reading for short periods of time (30 minutes or less).	45	30	25	28	29	43
8. If you are reading for long periods of time (30 minutes or more).	32	52	16	30	48	22
9. Produces less fatique.	26	55	19	18	57	25
10. Ability to maintain your place while reading.	55	27	19	59	14	27

Table 4-14. Participants' Reactions to Machine Features, Elinfa, Baltimore

	RATING				
	1*	2	3	4	5
1. Dot height of the display.	-	1	7	8	3
2. Dot spacing of the display.	-	-	6	5	8
3. Firmness of dots in the display.	-	2	3	10	4
4. The placement of the display on the machine.	-	-	6	4	8
5. The length of the braille display.	2	7	4	4	2
6. The placement of the controls on the machine.	2	5	8	2	2
7. The ease with which you are able to operate the controls.	-	8	4	3	4
8. The method for bringing up the next line.	-	6	3	9	1
9. The method for going back one line.	11	4	1	1	-
10. The method to locate a specific article.	11	5	1	-	1
11. The time required to locate specific articles.	7	7	2	1	1
12. The portability of the machine.	-	-	5	4	9
13. The machine when used in the battery mode.	-	-	2	7	7
14. The machine when used with the power cord.	-	1	1	4	11

* 1 Unsatisfactory
2 Below average
3 Average
4 Above Average
5 Excellent

Table 4-15. Participants' Reactions to Machine Features, Elinfa, Little Rock

	RATING				
	1*	2	3	4	5
1. Dot height of the display.	-	1	7	4	7
2. Dot spacing of the display.	-	-	7	4	8
3. Firmness of dots in the display.	-	3	5	6	5
4. The placement of the display on the machine.	-	-	8	4	6
5. The length of the braille display.	4	9	2	2	2
6. The placement of the controls on the machine.	1	6	8	4	-
7. The ease with which you are able to operate the controls.	-	2	7	9	1
8. The method for bringing up the next line.	5	2	6	4	2
9. The method for going back one line.	5	9	4	-	1
10. The method to locate a specific article.	3	3	8	4	1
11. The time required to locate specific articles.	3	6	5	5	-
12. The portability of the machine.	-	1	3	5	10
13. The machine when used in the battery mode.	-	2	2	6	9
14. The machine when used with the power cord.	-	-	1	5	11

* 1 Unsatisfactory
2 Below average
3 Average
4 Above Average
5 Excellent

Table 4-16. Participants' Reactions to Machine Features, Elinfa, Oklahoma City

	RATING				
	1*	2	3	4	5
1. Dot height of the display.	-	-	5	-	6
2. Dot spacing of the display.	-	-	4	2	5
3. Firmness of dots in the display.	-	1	4	1	5
4. The placement of the display on the machine.	-	-	5	2	4
5. The length of the braille display.	1	7	2	-	1
6. The placement of the controls on the machine.	-	1	9	1	-
7. The ease with which you are able to operate the controls.	1	2	4	2	2
8. The method for bringing up the next line.	4	2	2	2	1
9. The method for going back one line.	6	1	4	-	-
10. The method to locate a specific article.	2	3	5	1	-
11. The time required to locate specific articles.	2	1	7	-	1
12. The portability of the machine.	-	1	1	2	7
13. The machine when used in the battery mode.	-	-	2	1	4
14. The machine when used with the power cord.	-	-	1	3	7

* 1 Unsatisfactory
2 Below average
3 Average
4 Above Average
5 Excellent

Table 4-17. Participants' Reactions to Machine Features, Elinfa, Washington, D.C.

	RATING*				
	1	2	3	4	5
1. Dot height of the display.	-	3	4	-	4
2. Dot spacing of the display.	-	-	3	-	8
3. Firmness of dots in the display.	-	3	2	1	5
4. The placement of the display on the machine.	-	1	3	1	6
5. The length of the braille display.	1	2	4	1	3
6. The placement of the controls on the machine.	1	2	3	3	2
7. The ease with which you are able to operate the controls.	1	1	1	4	4
8. The method for bringing up the next line.	1	3	1	2	4
9. The method for going back one line.	4	3	3	1	-
10. The method to locate a specific article.	4	5	1	1	-
11. The time required to locate specific articles.	6	3	2	-	-
12. The portability of the machine.	-	3	1	1	6
13. The machine when used in the battery mode.	-	-	2	2	6
14. The machine when used with the power cord.	-	1	1	2	6

* 1 Unsatisfactory
2 Below average
3 Average
4 Above Average
5 Excellent

Table 4-18. Participants' Reactions to Machine Features, Elinfa, Summary

	PERCENT RATING*				
	1	2	3	4	5
1. Dot height of the display.	-	9	38	20	34
2. Dot spacing of the display.	-	-	33	18	49
3. Firmness of dots in the display.	-	15	23	30	32
4. The placement of the display on the machine.	-	2	39	19	41
5. The length of the braille display.	13	42	20	12	13
6. The placement of the controls on the machine.	7	24	45	17	7
7. The ease with which you are able to operate the controls.	3	22	27	30	18
8. The method for bringing up the next line.	17	22	20	28	13
9. The method for going back one line.	45	29	20	3	2
10. The method to locate a specific article.	35	27	25	10	3
11. The time required to locate specific articles.	33	31	20	2	4
12. The portability of the machine.	2	12	20	13	53
13. The machine when used in the battery mode.	-	4	15	31	50
14. The machine when used with the power cord.	-	4	7	25	64

* 1. Unsatisfactory
2 Below average
3 Average
4 Above Average
5 Excellent

Table 4-19. Participants' Reactions to Machine Features, VersaBraille, Los Angeles

	RATING				
	1*	2	3	4	5
1. Dot height of the display.	-	1	5	1	12
2. Dot spacing of the display.	-	-	4	3	12
3. Firmness of dots in the display.	-	2	1	4	12
4. The placement of the display on the machine.	1	2	8	4	4
5. The length of the braille display.	1	7	6	3	2
6. The placement of the controls on the machine.	-	3	9	4	3
7. The ease with which you are able to operate the controls.	-	1	8	5	5
8. The method for bringing up the next line.	-	3	10	3	3
9. The method for going back one line.	1	1	7	5	5
10. The method to locate a specific article.	-	1	6	4	8
11. The time required to locate specific articles.	-	5	8	2	4
12. The portability of the machine.	1	5	6	5	2
13. The machine when used in the battery mode.	1	3	8	2	5
14. The machine when used with the power cord.	1	3	6	6	3

* 1 Unsatisfactory
2 Below average
3 Average
4 Above Average
5 Excellent

Table 4-20. Participants' Reactions to Machine Features, VersaBraille, Washington, D.C.

	RATING*				
	1	2	3	4	5
1. Dot height of the display.	-	2	4	7	19
2. Dot spacing of the display.	-	-	5	8	19
3. Firmness of dots in the display.	-	2	4	6	20
4. The placement of the display on the machine.	1	4	8	10	9
5. The length of the braille display.	2	4	10	12	4
6. The placement of the controls on the machine.	-	4	8	9	11
7. The ease with which you are able to operate the controls.	-	-	4	14	14
8. The method for bringing up the next line.	-	3	6	9	14
9. The method for going back one line.	-	2	8	10	12
10. Th method to locate a specific article.	2	1	9	10	10
11. The time required to locate specific articles.	1	6	7	12	6
12. The portability of the machine.	3	5	10	6	8
13. The machine when used in the battery mode.	-	5	8	7	9
14. The machine when used with the power cord.	-	1	7	14	10

* 1. Unsatisfactory
2 Below average
3 Average
4 Above Average
5 Excellent

Table 4-21. Participants' Reactions to Machine Features, VersaBraille, Summary

	PERCENT RATING*				
	1	2	3	4	5
1. Dot height of the display.	-	6	18	16	61
2. Dot spacing of the display.	-	-	18	22	60
3. Firmness of dots in the display.	-	8	10	19	63
4. The placement of the display on the machine.	4	12	31	27	25
5. The length of the braille display.	6	22	31	29	12
6. The placement of the controls on the machine.	-	14	33	25	28
7. The ease with which you are able to operate the controls.	-	2	24	37	37
8. The method for bringing up the next line.	-	12	31	24	33
9. The method for going back one line.	2	6	29	29	34
10. The method to locate a specific article.	4	4	29	27	36
11. The time required to locate specific articles.	2	22	29	27	20
12. The portability of the machine.	8	20	30	22	20
13. The machine when used in the battery mode.	2	17	33	19	28
14. The machine when used with the power cord.	2	9	25	39	25

* 1. Unsatisfactory
2 Below average
3 Average
4 Above Average
5 Excellent

Table 4-22. Profile of Participants, Each City

BALTIMORE, MARYLAND

AGE	SEX	EDUCATIONAL LEVEL
19	M	High School Graduate
22	M	2nd Year College
23	M	Bachelor's Degree
25	M	3rd Year College
28	F	1st Year College
28	M	Bachelor's Degree
29	F	Bachelor's Degree
29	M	Bachelor's Degree
30	M	2nd Year College
33	F	Bachelor's Degree
33	M	High School Graduate
34	F	Bachelor's Degree
36	F	High School Graduate
36	F	Bachelor's Degree
46	F	High School Graduate
50	F	PhD
52	M	Master's Degree
53	M	4 Years College
62	M	Master's Degree

LITTLE ROCK, ARKANSAS

AGE	SEX	EDUCATIONAL LEVEL
21	F	High School Graduate
23	M	3rd Year College
26	M	Bachelor's Degree
27	F	Master's Degree
27	M	2nd Year College
27	F	Bachelor's Degree
28	M	High School Graduate
29	F	Master's Degree
32	F	Bachelor's Degree
33	F	Master's Degree
35	M	Master's Degree
36	F	1st Year College
38	M	Master's Degree
39	M	Master's Degree
40	F	1st Year College
45	F	2nd Year College
51	M	Bachelor's Degree
52	M	Master's Degree
67	F	Master's Degree

Table 4-22. Profile of Participants, Each City - Continued

OKLAHOMA CITY, OKLAHOMA

AGE	SEX	EDUCATIONAL LEVEL	AGE	SEX	EDUCATIONAL LEVEL
26	M	High School Graduate	45	M	Master's Degree
27	F	High School Graduate	49	F	Master's Degree
31	F	High School Graduate	51	F	2nd Year College
34	F	2nd Year College	52	M	Bachelor's Degree
35	F		56	M	
39	M		60	F	
43	F	High School Graduate	69	F	Grade School
43	M	Bachelor's Degree	79	M	2nd Year College

LOS ANGELES, CALIFORNIA

AGE	SEX	EDUCATIONAL LEVEL	AGE	SEX	EDUCATIONAL LEVEL
22	M	3rd Year College	34	F	Master's Degree
23	M		36	M	
24	M		36	F	Bachelor's Degree
25	F		41	F	Bachelor's Degree
27	F	3rd Year College	48	M	Bachelor's Degree
28	F	High School Graduate	50	M	Bachelor's Degree
29	M	1st Year College	51	F	10th Grade
30	F	Bachelor's Degree	51	F	High School Graduate
30	F	Bachelor's Degree	61	M	Bachelor's Degree
33	M	Bachelor's Degree	70	F	3rd Year College

Table 4-22. Profile of Participants, Each City - Continued

VERSABRAILLE

WASHINGTON, D.C.

AGE	SEX	EDUCATIONAL LEVEL
16	F	Senior in High School
18	F	High School Graduate
21	F	1st Year College
22	F	Bachelor's Degree
22	F	2nd Year College
24	M	Bachelor's Degree
24	F	Bachelor's Degree
25	M	Bachelor's Degree
26	M	3rd Year College
27	F	Bachelor's Degree
28	F	Master's Degree
28	F	High School Graduate
30	F	Bachelor's Degree
30	M	Master's Degree
31	F	PhD
31	M	2nd Year College
32	M	PhD
33	F	Bachelor's Degree
34	M	PhD
35	M	Bachelor's Degree
35	F	Bachelor's Degree
38	F	3rd Year College
40	F	Master's Degree
42	F	High School Graduate
43	F	Master's Degree
49	M	Master's Degree
49	M	Bachelor's Degree
49	M	LLB
51	F	High School Graduate
54	M	4th Year College
56	F	High School Graduate
57	M	High School Graduate

Table 4-22. Profile of Participants, Each City - Continued

ELINFA

WASHINGTON, D.C.

AGE	SEX	EDUCATIONAL LEVEL
21	F	High School Graduate
25	F	High School Graduate
32	F	1st Year College
33	F	Bachelor's Degree
35	M	High School
35	F	Bachelor's Degree
38	M	Bachelor's Degree
38	F	1st Year College
51	F	1st Year College
53	M	JD

Section II. READING TEST MATERIAL

NOTE

Captions under the pictures and the table "The World's Major Earthquakes" were not included in the reading test material.

Our Trembling Earth

No one who has experienced a severe earthquake can ever forget the feeling of terror and helplessness that grips him when the ground under his feet begins to shake like a troubled sea. But no one who has *not* experienced a strong quake can understand the blind, unreasoning fear it triggers. Most people are only dimly aware of the frequency and destructive power of earthquakes. As a matter of fact, the earth trembles sufficiently to produce a shock every 30 seconds on the average; each year about a million quakes rock our planet. In this century alone (a century that is not nearly over) a million deaths, plus great suffering and damage, have been caused by the destructive force of great blocks of the earth's crust on a rampage.

The atomic bomb was introduced in World War II with terrible impact, killing tens of thousands and destroying great cities in a matter of seconds. A large earthquake has the power of not just one such bomb, but 100,000 of them. We shall see in the next chapter what happens when such a fearful force is unleashed in populated areas.

While there are zones where the risk of earthquakes is far greater than in others, no place on earth is completely free from them. Perhaps only in outer space would one be completely safe. For example, Charleston, South Carolina, not generally considered a danger area, was rocked in 1886 by an earthquake that killed many persons and damaged much of the city. In 1811 even stronger shocks had hit the region around New Madrid, Missouri, once thought to be much less prone to quakes than the eastern seaboard. However, our real "earthquake country" is found in the West, particularly Alaska and California.

For Alaskans, the jolting realization of earthquake danger came in 1964 when a great shock devastated several cities and then flooded them with monster waves from the sea. Californians, long accustomed to severe shaking, suffered a major death-dealing quake in 1971. Residents of other lands have also been victims, sometimes by the thousands, in recent earthquakes. Managua, Nicaragua, is a tragic example. Those fortunate enough to survive such catastrophes cannot take comfort for long, because there will be future shocks as severe as the ones they have experienced already.

Generally a quake brings to mind the ground pitching and rolling like the angry sea, with buildings and other structures toppling on luckless victims. But there are other terrors too. Volcanoes are often associated with quakes; sometimes they themselves are the killers. Vivid proof of the earth's growing pains and of its fierce internal heat and pressure, volcanoes have buried entire cities. Mt. Pelée, Krakatoa, and the classic Mt. Vesuvius are examples. The United States is fortunate in having had no destructive volcanoes recently, but Mexico from 1943 to 1952 witnessed the thundering growth of a new "mountain" 1,200 feet high in a farm field. In Iceland, volcanoes thrust up new islands from the sea in a fierce and angry birth amid fire and explosion. And long-dormant Helgafell volcano on the tiny island of Heimaey forced the hurried evacuation of its 5,200 residents early in 1973.

The sea too can be churned up by quakes. Tidal waves, or

A new view of a two-month-old volcano on Iceland's Heimaey island shows houses being buried in the path of its lava flow. The island's population of 5,300 was evacuated in February 1973 when the volcano erupted. *(Associated Press)*

tsunamis, as the Japanese, who suffer most, have named them, are major killers. Alaska was a recent victim, but Hawaii has long known the terror of these giant waves that race across the ocean at speeds exceeding 600 miles an hour and drown cities under dozens of feet of water.

Seen from a spacecraft, swathed in its wrapping of clouds, the earth seems as solid as a bowling ball, spinning serenely as it makes its orbit of the sun each year. What cannot be seen in this

majestic overview is the internal structure of the earth, a structure so complex that geologists still cannot explain it completely. The moon, far "deader" than the earth, may still be experiencing internal tremors. The earth is much more active, with a core of molten metal and a "mantle" of plastic rock that have not yet reached a state of equilibrium. The earth rotates at a speed of 1,000 miles an hour at the equator: faster than a 747 jetliner. Liquid inside, and crusted by gigantic slabs of rock that have not yet "set," the huge spinning ball is subjected to a colossal force. As a result, great "plates" of rock drift ponderously on their soft foundations. The history of these driftings, and the resultant formation of the continents we live on, is being laboriously pieced together by scientists.

It is becoming evident that earthquakes are not casual accidents but part of the forces shaping the earth's features. The mountains that are thrust up from the plains are produced by the same "tectonic" forces that shake the land. The legendary continent Atlantis is thought by some authorities to have been swallowed up by earthquakes rocking the Mediterranean. Colossal forces were evidently at work in the pushing up of such great mountain ranges as the Himalayas and America's Sierras and Rockies. Even the minor slippages that merely ease the strains in flat country also produce cataclysmic shocks that demolish buildings.

Instead of a ball of solid matter, then, the earth is more like a living thing, still hot inside and beset by "growing pains." The dramatic "Ring of Fire," the volcanic earthquake belt encircling the huge Pacific Ocean, is a result of the massive activity that continues inside the earth.

Over the ages, the earth's tremblings have produced natural geographical features. Even in these natural features subsequent quakes often raise havoc. But human engineers have involved themselves in nature's feature building. We are dirt-movers supreme, and many of our cities are on "made" land, dirt hauled in and packed down—sometimes poorly—to provide building sites. Earthquakes are doubly hard on such

ground. Nature produces no skyscrapers, bridges, or towering dams. And quakes crack these apart and throw them down more fiercely than they do the natural features that over the years have adjusted themselves to periodic shakings.

Mankind probably has been shaken ever since it appeared on earth. Quakes were doubtless more severe and more frequent when the earth was even less settled down than it is now. In those earlier times people were hampered by a lack of understanding of quakes and had few ways to protect themselves. Casualties often were enormous when the earth went on its periodic rampages. Today the increase in popu'ation leads to increasing danger from quakes, which each year become more dangerous environmental hazards. By the year 2000 it is estimated estimated that 75 million Americans will live on or near *an active earthquake fault*. Not only do people continue to live directly atop devastating earthquake faults, but others move into such areas and build on them. Increasing numbers of us live as did the legendary King Damocles, except that the danger is not suspended from above on a slender thread but threatens from below, in the massive blocks of the earth's crust precariously balanced on one another.

The San Francisco quake of 1906 is a classic example of terror and destruction in our country (although only some 700 people died there, in contrast to tens and even hundreds of thousands killed by single quakes in other lands). Today metropolitan San Francisco is the home of more than three million people, more than lived in the entire state at the turn of the century. Even more frightening is the thought of a major quake striking an area like Los Angeles, with its some seven million people, or New York, with more than ten million.

Hurricanes, floods, or other natural catastrophes, and even man-made disasters such as nuclear bombings, generally are heralded by some advance warning. But a quake happens when it happens, often giving no warning at all. Suddenly the ground heaves crazily, buildings collapse, and destruction results. It is difficult to prepare for earthquakes; even the best-intentioned, most knowledgeable people cannot maintain an attitude of alert preparedness for weeks, months, and years. Sooner or later, watchfulness is relaxed, and when quakes strike again the resulting havoc is as bad as or worse than what had occurred earlier. Because a quake is generally considered "an act of God," many people accept the danger fatalistically, believing that nothing can be done except to pray.

For others, preparation for an earthquake is somewhat like concern for a roof that needs repair: When it is not raining it is no problem, and when the downpour comes it is difficult to do anything about it. Complicating the issue is the question of how much—if anything—we can do about earthquakes. Fortunately

Few people can still remember the 1906 San Francisco earthquake, but the horror of it is preserved in photos such as this. *(Caltech)*

there are some protective measures. Engineers and government officials have long urged strict building codes in earthquake areas. Such wise regulations are more likely to be heeded immediately after a devastating quake. In between times it is difficult or even impossible to persuade property owners to pull down what appear to be perfectly serviceable structures; or to make taxpayers invest additional dollars to meet earthquake standards.

Ecology, almost a household word these days, teaches that we must learn to live with nature, rather than oppose it. This sensible warning applies especially to earthquakes. Where we build and how we build are of vital importance in our ability to weather a severe quake. Fortunately we have progressed from blind fear of earthquakes to some basic understanding of their mechanism. We have learned ways to safeguard life and property to some extent. "Earthquake engineering" is becoming a factor in protecting life and property. Some scientists and engineers believe that earthquake *prediction* may be possible, and researchers in several countries are working in that direction with interesting results. Most remarkable of all are suggestions that not only can earthquakes be predicted, but it may even be possible to *control* them!

Quakes are frightening for their awesome power and for their tendency to strike without warning. They represent forces once thought far beyond man's ability to cope. Interest in them should not be limited to the thrills and excitement they generate but should include learning how to minimize the danger that threatens more inhabitants of earthquake country than ever before.

Earthquakes in History and Myth

Seismologists assure us that earthquakes have long been part of the earth's growing pains, but there are more tangible ways to prove the occurrence of earthquakes long ago—for myth, legend, and history indicate that the earth has always been a shaky place to live. The earliest accurate recording of a quake and its toll was in the year A.D. 856 in Corinth, Greece, a city that has been destroyed nine times in this manner! There were 45,000 killed in that quake, a death toll that is terrible to consider. Yet since that time there have been far greater earthquake disasters. The table "The World's Major Earthquakes" (page 10) includes only those in which fatalities exceeded 20,000.

Early explanations of the causes of such terrifying happenings were not accurate, of course. Some primitive peoples thought the earth rode on the back of a gigantic tortoise or a giant frog. Another concept favored bulls, four of whom held up the planet. Such mythical props were necessary because unscientific minds could not believe that the earth hung unsupported in space. When early Greeks began to think more highly

THE WORLD'S MAJOR EARTHQUAKES

Year	*Place*	*Toll*
1556	Shensi, China	830,000
1737	Calcutta, India	300,000
1920	Kansu, China	180,000
1923	Tokyo-Yokohama, Japan	143,000
1290	Chihli, China	100,000
1667	Shemakha, Caucasia	80,000
1908	Messina, Italy	75,000
1932	Kansu, China	70,000
1970	Northern Peru	70,000
1268	Silicia, Asia Minor	60,000
1693	Catania, Italy	60,000
1755	Lisbon, Portugal	60,000
1935	Quetta, Pakistan	60,000
1783	Calabria, Italy	50,000
856	Corinth, Greece	45,000
1797	Quito, Ecuador	41,000
1755	Northern Persia	40,000
1293	Kamakura, Japan	30,000
1531	Lisbon, Portugal	30,000
1759	Baalbek, Lebanon	30,000
1828	Echigo, Japan	30,000
1915	Avezzano, Italy	30,000
1939	Chillán, Chile	30,000
1057	Chihli, China	25,000
1868	Peru and Ecuador	25,000
1038	Shansi, China	23,000
1939	Erzincan, Turkey	23,000
1822	Aleppo, Asia Minor	22,000
1896	Sanriku coast, Japan	22,000
1905	Kangra, India	20,000

of themselves, the manlike god Atlas held the world on his shoulders.

It was never quite clear what Atlas or the tortoise or the four bulls were standing on, and with such a foundation it was easy to conceive reasons for earthquakes. If the tortoise or the bulls moved, so did the earth. The worst shocks were said to come when the bulls playfully tossed the planet from one pair of horns

to another! Other myths envisioned a giant, earth-girdling serpent which, in trying to devour its own tail, shook the planet savagely. The earth might even be a giant egg, with the shell cracking open to let out who knew what—perhaps another giant serpent.

Anaxagoras of Greece had a delightful theory that gives some idea how difficult it was in his time to arrive at meaningful causes for natural events like earthquakes. According to this early writer, the flat earth was kept rotating by some force whirling around it. This made it settle in the middle, as water does. However, when the air that buoyed us up from below was "disturbed by heat," it tossed the earth about like a cork in a rough sea. And this was the cause of earthquakes!

Babylonian tradition held that Saturn, Jupiter, and Mars were responsible for quakes. The early Chinese, like the Babylonians, believed that the stars foretold earthquakes. The writer Poyang Fu gave another explanation of quakes:

> When the Yang is hidden, and cannot come forth, or when the Yin bars its way and cannot rise up, then there is what we call an earthquake. Now we see that the three rivers have dried up by this shaking; it is because the Yang has lost its place and the Yin has overburdened it.

Early peoples made little distinction between earthquakes and volcanoes. They experienced both kinds of disasters and lumped them together as being of the same nature. The first record of an erupting volcano is a picture in a shrine at Catal Huyuk, in southern Anatolia, dated about 6200 B.C. This is thought to show the then-active volcanoes Karaca Dag and Hasan Dag. Eruptions of flame and lava led to the Roman belief in Vulcan and other fire gods, yet for ages these people lived on the slopes and around the base of the active volcano Vesuvius. In A.D. 63 there was a violent earthquake in the region, but residents were too content with their life in the fertile location to take precautions. Finally, in A.D. 72 the great volcano erupted and completely obliterated two cities and killed their inhabitants. In addition to the well-known Pompeii, Herculaneum was buried.

"EARTHQUAKE WEATHER"

The English writer Thomas Carlyle, in discussing the French Revolution, said "hope ushers in a revolution as earthquakes are preceded by bright weather." Since the earliest times there have been weird tales of advance warnings of earthquakes. Weather is often singled out as a predictor, and the erroneous notion of "earthquake weather" persists. Generally this is thought to be eerily still weather occurring in spring or fall. Lightning is also said to be associated with quakes, as are strange lights and smells. Animals reportedly can sense coming quakes: dogs bark and birds fly in terror.

Aristotle developed his own elaborate theory of earthquakes, believing they were caused by *pneuma*, subterranean winds like the breathing in and out of a human. He said quakes were more likely to occur in spring or autumn, during a drought or rainy period, probably when there was no wind. An eclipse of the moon might also bring them on. Surprisingly, some earthquake experts suggested that the moon was a factor in the recent San Fernando earthquake.

The Roman naturalist Pliny wrote:

> Tremors of the Earth never occur except when the sea is calm and sky so still that birds are unable to soar because all the breath that carries them has been withdrawn; and never except after wind, doubtless because then the blast has been shut up in the veins and hidden hollows of the sky.

Pliny also said that sailors could anticipate quakes by observing the birds' inability to fly, sudden waves, and a thin streak of cloud over a wide space in the sky. He also had an interesting explanation of why France and Egypt were relatively free of quakes: Earthquakes come less frequently in summer and winter, which are long seasons in those countries!

Pausanias, a Greek geographer, listed a number of weather warnings sent by the god Poseidon prior to an earthquake. These included "continuous rainstorms or continuous droughts, hot winters, hazy sun in summer, flowing springs dry up, blasts of wind swoop upon the land and overturn trees, great

flames dart across the sky, stars appear that have never been witnessed before, and there is a violent rumbling of winds beneath the earth." He also listed a particularly fortunate kind of quake in which, after the first shock had leveled buildings, an exact same one from the opposite direction set the buildings up again! Such quakes left "cracks cemented better than they could be by human craftsmen." Unfortunately there was far more fiction than fact in Pausanias's colorful report.

Although it would be helpful, there does not seem to be any such thing as earthquake weather or season. Quakes come at all times of the year and in all climates and conditions. The notion that earthquake weather is hot and sultry has been thoroughly disproved by the simple method of checking actual weather prevailing during major quakes in history. A Japanese seismologist did this for eighteen major quakes over five centuries and found that it was fair or clear during twelve of them, cloudy for two, raining or snowing for three, and windy for one. None occurred during humid, sultry "earthquake weather"! An American scientist made a similar survey of earthquake weather and agreed.

Neither is lightning or any particular smell associated with earthquakes, except that volcanic gases or ash may cause them. The ominous quiet and the panicked behavior of animals seem to be details filled in after the fact by superstitious humans. However, since animals generally are in closer contact with the ground than humans and have keener senses of hearing and touch, they may be aware of quakes slightly sooner. Frightening sounds do accompany quakes, of course. Rumblings from the ground occur, church bells ring, and buildings crack and creak. But it was a very long time before scientific explanations replaced superstition. Indeed, there are people who believe old tales yet.

PART II SUPERSTITIOUS BELIEFS

In a letter written in ancient Assyria, an official recorded the causes of earthquakes and the proper methods of protection from them:

> Let them perform whatever are the rites for an earthquake; the gods will cause it to pass away; Ea [the god responsible] has given release therefrom. Whoever causes the earthquake, the same provides an incantation for release.

Superstitious people have always believed that earthquakes are sent to punish wicked humans. Only if the gods were displeased with mankind would they want to destroy the earth. When the Minoan culture was annihilated by earthquakes, the gods were blamed, as they were when Atlantis disappeared beneath the sea. If people had been good they would have prospered and would not have been killed. However, those who believed in quakes as the wrath of the gods must have been confused when the Aegean island of Delos ("anchored to the sea floor by Zeus himself" and sacred to the prophet-god Apollo) was devastated by quakes in 490 B.C. before the Persian invasion, and again in 431 B.C. at the beginning of the Peloponnesian War. However, superstition seems an inevitable part of human nature, and ancient beliefs die hard.

An old Romanian legend describes the earth as resting on the three divine pillars of Faith, Hope, and Charity. When one of these symbols of morality wavered through the misdeeds of people, the earth shook in warning. And in the sixth century the Emperor Justinian decreed the death penalty for blasphemy or swearing by the hair of one's head, since such practices might provoke thunderbolts and earthquakes!

The Port Royal earthquake on the Island of Jamaica occurred June 7, 1692, two hundred years after Columbus discovered America, and Port Royal by then had established itself as one of the great "sin cities" of the time. When the quake came the whole northern part of the town slowly slid into the sea! Some of the buildings are still intact and can be seen under the water today. Two thousand Port Royal residents disappeared, no less than two-thirds of the city was destroyed, and a great number of ships were lost. To its credit, the earthquake did put an end to thievery and vice in Port Royal. It also kept alive the old superstitions.

The theologian John Wesley wrote, "There is no divine visitation which is likely to have so general an influence upon survivors as an earthquake." As late as 1750 it was customary for anyone attempting to explain earthquakes scientifically to apologize to those who could not accept natural causes in place of divine reasons. The British Royal Society in 1752 published in its transactions the statement that earthquakes occurred only where people needed chastening. Ironically, just three years later a terrible quake rocked Lisbon, Portugal, while most of its residents were in church.

The Lisbon earthquake struck on November 1, 1755, at 9:30 in the morning when almost everyone was attending All Saints' Day Mass. After the churches collapsed on worshipers, a huge "tidal wave" added to the toll, and sixty thousand were killed. Voltaire wrote his "Poem on the Disaster of Lisbon" in 1756, and he referred to the tragedy again in his satirical novel *Candide*, ridiculing the idea that the quake came as a punishment.

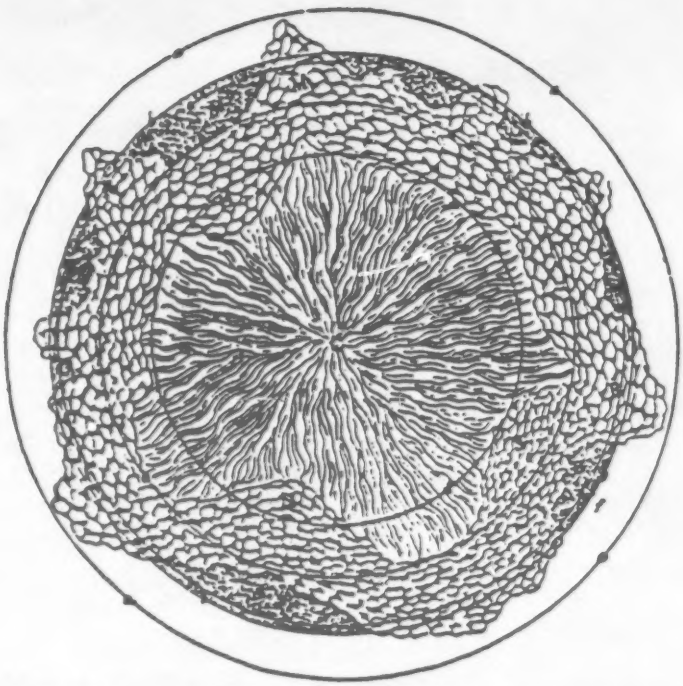
THE COMING OF EARTHQUAKE SCIENCE

With agonizing slowness over the centuries, superstitious guesswork about earthquakes inched nearer to fact. A few brave men began to look elsewhere than to the gods for answers. Democritus, who conceived the atom, suggested rain as a cause for quakes. The poet Ovid made the interesting proposal that when the earth wandered too near the sun it was shaken. This and theories about other planets' or the moon's being the cause were noteworthy, coming as they did long before the explanation of the force of gravity, which could indeed be a factor in earthquakes.

The Roman philosopher Lucretius suggested that the dislodgement of masses of rock and dirt in subterranean caverns and chasms was a cause. This idea foreshadowed the present fault theory of quakes. Some shrewd observers noticed other natural events that occurred during or even before quakes.

For example, the hot springs at Adepsus and Thermopylae stopped flowing just prior to an earthquake, although they were far from the center of the shock. Many centuries later, in 1755, the odd relationship between well-water levels and an earthquake was noted in connection with the severe quake in Lisbon. It is still being studied as a possible source for quake prediction.

In the same year as the Lisbon disaster, a quake rocked Boston, Massachusetts, and a lecture given shortly afterward indicated that although much had been learned about quakes,



Abbe Anton Lazzaro Moro, a leading Italian plutonist of the eighteenth century, drew this picture of an earth whose center was filled with fire which caused earthquakes.

real scientific explanations were still far away. Harvard's Professor John Winthrop offered this then-current theory in a lecture at the college:

> Now we know of nothing in nature more powerful than the particles of certain bodies converted into vapor by the action of fire. Fire then, and proper materials for it to act upon, it is probable, are the principal agents in this affair. . . . The vapors will rush along through the subterranean grottos as they are able to find or force for themselves a passage; and by heaving up the earth that lies over them, will make that kind of progressive swell or undulation, in which we have supposed earthquakes commonly to consist; and will at length burst the caverns with a great shaking of the earth . . . and so discharge themselves into the open air.

Erroneous as Winthrop's theory was, it was scientific by comparison with other beliefs of the time. For example, many Americans thought that Ben Franklin's new "electrical substance" was to blame for earthquakes, particularly in cities like Boston, which had "many points of iron sticking up"! In the two centuries since, scientists have learned a great deal about earthquakes.

Section III. READING TESTS, QUESTIONNAIRE, CONCEPT AND MACHINE FEATURES FORMS, AND LOG KEEPING INSTRUCTION LETTER

CASSETTE BRAILLE EVALUATION

TEST - READING COMPREHENSION

Name: _____

Time: _____

TEST ANSWERS

Question #1	A	B	C
Question #2	A	B	C
Question #3	A	B	C
Question #4	A	B	C
Question #5	A	B	C

CASSETTE BRAILLE EVALUATION

FINAL TEST - READING COMPREHENSION

Name:_____

PART 1

Time:_____ Cassette/Paper

Question #1	A	B	C
Question #2	A	B	C
Question #3	A	B	C

PART 2

Time:_____ Cassette/Paper

Question #1	A	B	C
Question #2	A	B	C
Question #3	A	B	C

CASSETTE-BRAILLE EVALUATION

QUESTIONNAIRE

Name: _____

Address: _____

_____

Telephone: _____

Date of Birth: _____

Educational Level: _____

Occupation: _____

Part Time: _____ Full Time: _____ Unemployed: _____

Degree of Blindness: _____

Where did you learn to read braille? _____

How long have you been reading braille? _____

Do you read braille with both hands? _____

If you read with one hand, are you right or left-handed? _____

In reading paper braille, do you normally place the reading material on a desk, table, or hold it against your body? _____

Is braille reading required in your work? _____. If yes, approximately how many hours of your working day? _____

Approximately how many braille magazine titles or book titles did you read during the month prior to the start of this program? _____

CASSETTE-BRAILLE VERSUS PAPER BRAILLE

Your response to the following matters will help determine the advantages and/or disadvantages of cassette braille and paper braille. Please indicate your preference in the space provided.

	Prefer Cassette Braille	Prefer Paper Braille	No Preference
1. Ability to initially locate specific articles.			
2. Ability to skim material - both forware and backward.			
3. Space requirements for braille material.			
4. For reading speed.			
5. For reading comprehension.			
6. Missing or unreadable characters or words.			
7. If you are reading for short periods of time (30 minutes or less).			
8. If you are reading for long periods of time (more than 30 minutes).			
9. Produces less fatique.			
10. Ability to maintain your place while reading.			

A. Would conversion by The Library from paper braille to a cassette braille system, cause a problem for you? _____ If so, why? _____

_____

B. With a reading machine, would you prefer to read magazines or books? (Use an extra sheet, if necessary) _____

_____

_____

The following items pertain to the features and usage of cassette braille reading machine. Please rate your responses to these matters on a one to five scale.

1. Unsatisfactory
2. Below average
3. Average
4. Above average
5. Excellent

1.	Dot height of the display	1	2	3	4	5
2.	Dot spacing of the display	1	2	3	4	5
3.	Firmness of dots in the display	1	2	3	4	5
4.	The placement of the display on the machine	1	2	3	4	5
5.	The length of the braille display	1	2	3	4	5
6.	The placement of the controls on the machine	1	2	3	4	5
7.	The ease with which you are able to operate the controls	1	2	3	4	5
8.	The method for bringing up the next line	1	2	3	4	5
9.	The method for going back one line	1	2	3	4	5
10.	The method to locate a specific article	1	2	3	4	5
11.	The time required to locate specific articles	1	2	3	4	5
12.	The portability of the machine	1	2	3	4	5
13.	The machine when used in the battery mode	1	2	3	4	5
14.	The machine when used with the power cord	1	2	3	4	5

Using the space below, please feel free to express your opinion—positive and negative—on any aspect of the machine.

VSE CORPORATION
FORMERLY VALUE ENGINEERING COMPANY

2550 HUNTINGTON AVENUE
ALEXANDRIA, VIRGINIA 22303

May 1980

Dear Braille Readers:

The purpose of this letter is to clarify procedures for completing reader logs. We hope that our suggestions will simplify the task.

First, keep a running record of the data--on scraps of paper if you wish. Braille these data on the log sheets covering a two-week period. Send the log sheet or sheets to us monthly in the stamped self-addressed envelopes already provided.

The log should be divided into two sections. The first section should contain the number of hours read over a two-week period, the titles of magazines, and the articles read from each magazine during the same period. Be sure to include the beginning and ending dates of the period.

The second section should contain general comments about the machine, the materials, or any other aspect of the program. If you point out a problem, please be specific.

Thank you for your cooperation in the matter. Remember, if you need to reach us by phone, call collect (703) 960-1589.

Very truly yours,

VSE CORPORATION

James R. Ward
Program Manager

JRW/mam

(CAPITAL BELTWAY EXIT 2B, ROUTE 241 SOUTH, TELEGRAPH ROAD) (703) 960-4600, TWX 710-832-1155

Section IV. HISTORY OF MACHINE REPAIRS

History of Elinfa Machines Returned for Repairs

DATE	MACHINE NO.	PROBLEM
August 26, 1981	109	dead display
	125	cell 16-6
	126	cell 1-6
	134	will not read
	151	will not read
	154	cell 18-5
July 20, 1981	121	tape advance will not read
	137	cell 4-5, cell 18-3
	148	cell 1-3, cell 15-all
July 7, 1981	109	cell 1-3
	101	display not activated
	129	tape will not advance
	154	cell 8-1,, cell 4-5, cell 6-5, cell 10-
	145	low battery warning
February 19, 1981	121	will not read
	151	cell 2-3 & 6, cell 19-3 & 6
	153	will not read
January 14, 1981	122	no display - no counter
	129	will nor read tape
	143	cell 3-3, cell 5-3
	114	uneven display
	111	uneven display
	148	will not read
	152	many dots up when they should not
	112	cell 13-2
	154	low display
	101	cell 5-1 & 2
	145	cell 14-5
November 7, 1980	134	cell 1-5, cell 7-5, cell 14-2

DATE	MACHINE NO.	PROBLEM
November 7, 1980	140	cell 1-2 & 5, cell 5-6, cell 6-6
		cell 7-2, cell 8-1 & 2, cell 9-6
		cell 10-3, cell 11-3, cell 12-2
		cell 14-5, cell 16-2, cell 18-6
		cell 19-2, cell 20-2
October 27, 1980	105	no display - multifunction and index key pushed in
	115	cell 1-3, cell 2-5, cell 13-4
	135	cell 2-3 & 6, cell 3-1 & 5, cell 4-2, cell 9-3, cell 17-6, cell 20-1, 5 & 6
October 3, 1980	130	will not read
	142	will not read
	136	low soft display
September 11, 1980	120	cell 1-1, 2, 3 & 4, cell 2-4, cell 3-1, cell 5-3 & 6, cell 6-3, cell 7-1 & 6, cell 9-5, cell 17-3, cell 18-4 & 6, cell 20-1, 2, 5 & 6
	121	will not read
September 2, 1980	107	cell 14-2
	111	cell 2-6
	113	soft display
	128	continuous error tone
	142	cell 16-1
	151	fast forward okay, will not disengage - machine dropped - case damaged
August 14, 1980	101	cell 2-5, cell 5-3, cell 9-6
		cell 12-6, cell 15-2, cell 16-4 & 6
	121	cell -
July 28, 1980	102	counter always reads 007
	106	will not read
	109	cell 15-1, cell 17-1, cell 13-5, cell 12-4
	110	will not read
	111	cell 8-1, cell 15-3 & 6
	112	cell 1-1 & 2, cell 2-6
	125	will not read

DATE	MACHINE NO.	PROBLEM
July 28, 1980	151	will not read
	153	will not read
May 27, 1980	102	cell 2-4
April 29, 1980	129	will not read
	142	uneven display (see data)
March 26, 1980	102	cell -6
	107	will not read
	110	will not read
	128	continuous error tone
	149	rewind key has to be forced
January 15, 1980	104	vibration in machine
	107	uneven display
	132	eneven display - cassette door sticks

History of VersaBraille Machines Returned for Repairs

DATE	MACHINE NO.	PROBLEM
October 23, 1981	P-106-025	pins
September 11, 1981	P-106-013	cell 14-4
September 30, 1981	P-105-009	will not read correctly
August 28, 1981	P-106-003	will not read
July 1, 1981	P-103-020	cell 10-6
	P-105-002	will not read
	P-106-005	will not hold charge
	P-106-006	cell 2-3
June 12, 1981	P-105-009	over heating
May 13, 1981	P-106-007	will not charge
	P-105-003	cell 15-1
	P-104-020	cell 11-6, cell 16-6
	P-106-002	erased first page of article
February 5, 1981	P-104-014	cell 5-4, will not eject cassette
	P-104-016	will not read - rejects cassettes
	P-105-002	word search will not work
November 3, 1980	P-104-020	will nor read
June 11, 1980	P-104-020	cell 9-3
June 9, 1980	P-105-009	will not read
May 13, 1980	P-104-009	cell 17-2

Section V. DETERMINATION OF CHARACTERS PER WORD DATA

DETERMINATION OF AVERAGE CHARACTERS PER 20 CELL LINE AND NUMBER OF BLANK SPACES AT END OF LINE

Magazine: PSYCHOLOGY TODAY - July

Article: Newsletter

Pages: 2 - 3 - 4

Page 2	773 Characters/Page 193 Words/Page	=	3.98 Characters/Word
Page 3	792 Characters/Page 194 Words/Page	=	4.08 Characters/Word
Page 4	804 Characters/Page 174 Words/Page	=	4.61 Characters/Word
	Average Characters/Word	=	4.21

616 Blank Spaces at the end of the Line for the 3 pages.
172 Lines for the 3 pages

$$\frac{616}{172} = 3.58 \text{ Empty Spaces/Line}$$

Rounding all Numbers Upwards

5 Characters/Word
4 Empty Spaces

5 + 6* + 6 = 17 Characters/Line

A Word Count for these Pages

Page 2	188 Words/54 Lines	=	3.48 Words/Line
Page 3	190 Words/54 Lines	=	3.52 Words/Line
Page 4	170 Words/59 Lines	=	2.88 Words/Line
	Average Words/Line	=	3.28

* Allow for One Space Between Words

Magazine: PLAYBOY - July

Article: Short Story

Pages: 2 - 3 - 4

Page 2	771 Characters/Page 220 Words/Page	=	3.5 Characters/Word
Page 3	771 Characters/Page 210 Words/Page	=	3.67 Characters/Word
Page 4	763 Characters/Page 214 Words/Page	=	3.57 Characters/Word
	Average Characters/Word	=	3.58

449 Blank Spaces at the End of the Line for the Three Pages
159 Lines for the Three Pages

$\frac{449}{159}$ = 2.82 Empty Spaces/Line

Magazine: BETTER HOMES AND GARDENS - July

Article: Recipes

Pages: 2 - 3 - 4

Page 2	804 Characters/Page 185 Words/Page	=	4.37 Characters/Word
Page 3	792 Characters/Page 192 Words/Page	=	4.15 Characters/Word
Page 4	803 Characters/Page 184 Words/Page	=	4.36 Characters/Word
	Average Characters/Word	=	4.29

476 Empty Spaces at the End of the Line for the Three Pages
163 Lines for the Three Pages

$\frac{476}{163}$ = 2.92 Empty Spaces/Line

Magazine: FAMILY HEALTH - July

Article: Brilkin - The Evidence

Pages 2 - 3 - 4

Page 2	804 Characters/Page 185 Words/Page	=	4.35 Characters/Word
Page 3	799 Characters/Page 184 Words/Page	=	4.34 Characters/Word
Page 4	796 Characters/Page 186 Words/Page	=	4.32 Characters/Word
	Average Characters/Word	=	4.32

484 Empty Spaces at the End of the Line for the Three Pages
161 Lines for the Three Pages

$\frac{484}{161}$ = 3.01 Empty Spaces/Line

Magazine: BRAILLE Variety News - July

Article: Paul Anka

Pages: 2 - 3 - 4

Page 2	794 Characters/Page 187 Words/Page	=	4.25 Characters/Word
Page 3	784 Characters/Page 199 Words/Page	=	3.94 Characters/Word
Page 4	808 Characters/Page 179 Words/Page	=	4.51 Characters/Word
	Average Characters/Word	=	4.22

487 Empty Spaces at the End of the Line for the Three Pages
159 Lines for the Three Pages

$\frac{487}{159}$ = 2.75 Empty Spaces/Line

SUMMARY

Magazine	Characters/ Word	Empty Spaces at End of Line	Spaces Used*	Empty Spaces at End of Line
Psychology Today	4.21	3.58	17	4
Playboy	3.58	2.82	19	3
Better Homes	4.29	2.92	17	3
Family Health	4.32	3.01	17	3
B.V.N.	4.51	2.75	17	3

The Trend appears to be that 3 more spaces on a 20 cell line may allow another word to be displayed.

* All numbers rounded up

Section VI. MAGAZINE PRODUCTION COST DATA

PLAYBOY

Cost to Produce Paper Magazine $7.19/Copy

% of Cost/Copy

Master*	37
Paper	25
Labor	31
Material	7

* Includes Labor for this Operation

Average Pages/Copy	467
Average Copies/Month	1150

Cost to Produce Cassette Magazine

Master 7.19 x 37%	$2.66
Cost of Cassette	0.75**
Labor and Other	0.75
	$4.16

** Assume the use of One Cassette

$7.19 Paper
4.16 Cassette
$3.03 Cost Savings

FAMILY HEALTH

Cost to Produce Paper Magazine $2.27/Copy

% of Cost/Copy

Master	31
Paper	24
Labor	32
Material	13

Average Pages/Copy	134
Average Copies/Month	1350

Cost to Produce Cassette Magazine

Master $2.27 x 31%	$0.70
Cost of Cassette	0.75
Labor and Other	0.75
	$2.20

$2.27 Paper
2.20 Cassette
$0.07 Cost Savings

PSYCHOLOGY TODAY

Cost to Produce Paper Magazine	$4.45/Copy
% of Cost/Copy	
Master	29
Paper	18
Labor	48
Material	5
Average Pages/Copy	235
Average Copies/Month	1074

Cost to Produce Cassette Magazine

Master $4.45 x 29%	$1.29
Cost of Cassette	.75
Labor and Other	.75
	$2.79

$4.45 Paper
2.79 Cassette
$1.66 Cost Savings

BETTER HOMES & GARDENS

Cost to Produce Paper Magazine	$4.59/Copy
% of Cost/Copy	
Master	25
Paper	20
Labor	50
Material	5
Average Pages/Copy	271
Average Copies/Month	1350

Cost to Produce Cassette Magazine

Master 4.59 x 25%	$1.15
Cost of Cassette	0.75
Labor and Other	0.75
	$2.65

$4.59 Paper
2.65 Cassette
$1.94 Cost Savings

NEW YORK TIMES

Cost to Produce Paper Magazine	$1.44/Copy
% of Cost/Copy	
Master	24
Paper	32
Labor	37
Material	7
Average Pages/Copy	97
Average Copies/Month	2100

Cost to Produce Cassette Magazine

Master 1.44 x 24%	$0.35
Cost of Cassette	0.75
Labor and Other	0.75
	$1.85

$1.85 Cassette
1.41 Paper
$0.41 Loss

LADIES HOME JOURNAL

Cost to Produce Paper Magazine	$4.35
% of Cost/Copy	
Master	23
Paper	32
Labor	36
Material	9
Average Page/Copy	235
Average Copies/Month	2300

Cost to Produce Cassette Magazine

Master 4.35 x 23%	$1.00
Cost of Cassette	0.75
Labor and Other	0.75
	$2.50

$4.35 Paper
2.50 Cassette
$1.85 Cost Savings

CHILDRENS DIGEST

Cost to Produce Paper Magazine	$1.97
% of Cost/Copy	
Master	54
Paper	16
Labor	22
Material	8
Average Pages/Copy	72
Average Copies/Month	475

Cost to Produce Cassette Magazine

Master 1.97 x 54%	$1.06
Cost of Cassette	0.75
Labor and Others	0.75
	$2.56

$2.56 Cassette
1.97 Paper
$0.59 Loss

The Average Cost of Paper/Page is $0.004

$$\frac{\text{Cassette Cost } \$0.75}{\text{Avg. Paper Cost/Page } \$0.004} = 187 \text{ Pages}$$

Therefore, magazines must have at least 187 pages for the cassette cost to be equal to or less than the paper magazine cost.